Ege University Publications
Faculty of Engineering Publication No. 72

XVI[th] INTERNATIONAL IZMIR TEXTILE AND APPAREL SYMPOSIUM

BOOK OF ABSTRACTS

25-27 October 2023
Altın Yunus Hotel, Cesme - izmir

www.iitas2023.com

Dalya

Ege University Publications
Faculty of Engineering Publication No: 72

XVITH INTERNATIONAL İZMİR TEXTILE & APPAREL SYMPOSIUM

IITAS 2023

OCTOBER 25 - 27, 2023
İZMİR-TÜRKİYE

BOOK OF ABSTRACTS

Organizer
IITAS 2023 is organized by Ege University
Faculty of Engineering, Department of Textile Engineering

IITAS 2023
XVI[TH] INTERNATIONAL İZMİR TEXTILE & APPAREL SYMPOSIUM

BOOK OF ABSTRACTS

EDITORS

E. Perrin AKÇAKOCA KUMBASAR	Ege University
Tuba BEDEZ ÜTE	Ege University
Mehmet KÜÇÜK	Ege University
Seniha MORSÜMBÜL	Ege University
Hale KARAKAŞ	İstanbul Technical University
A. Merih SARIIŞIK	Dokuz Eylül University

XVI[th] International İzmir Textile & Apparel Symposium
IITAS 2023
ISBN 978-605-338-429-8 (e-book)

This book was published by the decision of Ege University numbered 20 and dated 12.10.2023.

Turkish Ministry of Culture and Tourism Certificate No: *52149*

Ege University Publications
Ege University Printing and Publishing House
Bornova - Izmir
Tel: 0 232 342 12 52
Email: basimveyayinevisbm@mail.ege.edu.tr

Publication Links
https://basimveyayinevi.ege.edu.tr
https://textile.ege.edu.tr/tr-10330/iitas.html

e-Publication Date: December, *2023*

COOPERATION ORGANIZATIONS

Istanbul Textile and Apparel Exporters' Associations
www.itkib.org.tr/

Southeast Anatolian Exporters' Associations
www.gaib.org.tr

Uludağ Exporters' Association
www.uib.org.tr

Aegean Exporters' Associations
www.eib.org.tr

Mediterranean Exporter Associations
www.akib.org.tr

Denizli Exporters' Associations
https://www.denib.gov.tr

SUPPORTING ORGANIZATIONS

The Scientific and Technological Research Council of Türkiye
www.tubitak.gov.tr

Aygenteks İç ve Dış Ticaret Sanayi A.Ş.
www.aygenteks.com

Barine Tekstil San. İç ve Dış Tic. A.Ş.
www.thebarine.com

Bossa Ticaret ve Sanayi İşletmeleri T.A.Ş
www.bossa.com.tr

CU Tekstil San. ve Tic. A.Ş.
www.cuteks.com

EMR Fermuar Düğme ve Aksesuar
www.emrfermuar.com

Erka Mühendislik Müşavirlik Ltd. Şti.
www.erkamax.com

Fourkim Tekstil Boya ve Kimya Ürünleri A.Ş.
www.fourkim.com.tr

Menderes Tekstil
www.menderes.com

Onan Kimya San. ve Tic. Ltd. Şti.
www.onankimya.com.tr/

Özen Mensucat Boya ve Terbiye İşletmeleri A.Ş.
www.ozenmensucat.com.tr

Özgün Boya San. ve Tic. A.Ş.
www.ozgunboya.com

Sanko Tekstil İşletmeleri San. ve Tic. A.Ş.
www.sanko.com.tr

Serkon Teknoloji ve Yazılım Hizm. A.Ş.
www.genmak.net/genmak-makine.html

Sinateks Tekstil San. Tic. A.Ş
www.sinateks.com.tr

SÖKTAŞ Tekstil San. ve Tic. A.Ş.
www.soktas.com.tr

Sun Tekstil San. ve Tic. A.Ş.
www.suntekstil.com.tr

Uçak Tekstil
www.ucaktekstil.com.tr

Üniteks Tekstil
www.uniteks.com.tr

Wiser Globe
www.wiserglobe.com

Yünsa Yünlü Sanayi ve Ticaret A.Ş.
www.yunsa.com

ORGANIZING COMMITTEE

Prof. Dr. E Perrin AKÇAKOCA KUMBASAR
Chairperson of Organizing Committee
Ege University

Assoc. Prof. Dr. Tuba BEDEZ ÜTE
General Secretary
Ege University

Prof. Dr. Hale KARAKAŞ
Organizing Committee Member
İstanbul Technical University

Prof. Dr. A. Merih SARIIŞIK
Organizing Committee Member
Dokuz Eylül University

Assoc. Prof. Dr. Mehmet KÜÇÜK
Organizing Committee Member
Ege University

Dr. Seniha MORSÜMBÜL
Organizing Committee Member
Ege University

SCIENTIFIC COMMITTEE
(In Alphabetical Order)

Abdulkadir BİLİŞİK	Erciyes University, Türkiye
Andrej DEMSAR	University of Ljubljana, Slovenia
Bojana VONCINA	University of Maribor, Slovenia
Georgios PRINIOTAKIS	University of West Attica, Greece
Inga DABOLINA	Riga Technical University, Latvia
İsmail USTA	Marmara University, Türkiye
Maja RADETIC	University of Belgrade, Serbia
Mehmet TOPALBEKİROĞLU	Gaziantep University, Türkiye
Mirela BLAGA	Gheorghe Asachi Technical University of Iaşi, Romania
Monica ARDANUY	Universitat Politècnica de Catalunya, Spain
Necla YAMAN TURAN	Uşak University, Türkiye
Nevin Çiğdem GÜRSOY	İstanbul Technical University, Türkiye
R. Tuğrul OĞULATA	Çukurova University, Türkiye
Rıza ATAV	Namık Kemal University, Türkiye
Rimvydas MILAŠIUS	Kaunas University of Technology, Lithuania
Savvas G. VASSILIADIS	University of West Attica, Greece
Selçuk POYRAZ	Adıyaman University, Türkiye
Sibel KAPLAN	Süleyman Demirel University, Türkiye
Ümit Halis ERDOĞAN	Dokuz Eylül University, Türkiye
Vincent NIERSTRASZ	University of Borås , Sweden
Vladan KONCAR	ENSAIT, France
Yasemin KORKMAZ	Kahramanmaraş Sütçü İmam University, Türkiye
Y. Dilek KUT	Bursa Uludağ University, Türkiye
Yıldıray TURHAN	Pamukkale University, Türkiye
Yordan KYOSEV	Technische Universitat Dresden, Germany

Dear Participants,

The 16[th] of the International Izmir Textile and Apparel Symposiums, which have been held regularly since 1976, **IITAS 2023 (XVI[th] International Izmir Textile and Apparel Symposium) was carried out between 25-27 October 2023 in İzmir-Çeşme**, by Ege University Faculty of Engineering, Department of Textile Engineering. IITAS, which is organized every three years, aims to discuss current issues in the field of textiles, bring together many researchers and experts in the national and international arena, and exchange information on scientific developments and the latest innovations. IITAS is also an important event in terms of demonstrating the power of Türkiye in the field of textile and apparel, strengthening relations in this field, and establishing new collaborations. Organizing such a symposium in 2023 on the 100[th] Anniversary of the Republic of Türkiye has a special meaning.

As in the past International Izmir Textile and Apparel Symposiums, there was a high rate of participation in the symposium this year as well. **More than 450 participants** (38 foreign participants) from **20 different countries**, including academicians, middle and senior managers working in the textile and apparel industries, employers and students, participated in IITAS 2023.

The opening ceremony; including valuable opening speeches, a presentation entitled "**The Development of Textile Industry in the Republic of Türkiye**" and a panel on "**Opportunities and Threats for the Turkish Textile and Apparel Industry on the 100[th] Anniversary of the Republic**" was performed on 25 October. The plenary sessions held by well-known keynote speakers from home and abroad on 26-27 October 2023 were followed by oral and poster presentations in three parallel sessions, where innovative studies in the field of textile engineering were discussed by researchers. In these sessions, **68 oral presentations and 22 poster presentations** were made by a total of 24 researchers from industry and 44 academicians.

Thank you for your attendance to IITAS 2023, we hope to be together again at the IITAS 2026 in İzmir!

Best Regards

Prof. Dr. E. Perrin Akçakoca Kumbasar
Chairperson of Organizing Committee

XVI[th] INTERNATIONAL IZMIR TEXTILE AND APPAREL SYMPOSIUM

25-27 October 2023
Altın Yunus Hotel, Çeşme - izmir

OCTOBER 25, WEDNESDAY

16:00 - 17:00 REGISTRATION

17:00 - 20:00 OPENING SPEECHES - OPENING PRESENTATIONS - PANEL

OPENING SPEECHES

E. Perrin AKÇAKOCA KUMBASAR
Chairperson of IITAS 2023 Organizing Committee

Abdulkadir KONUKOĞLU
SANKO Holding, Honorary President, Türkiye

Burak SERTBAŞ
Vice Chairperson of the TIM Apparel Sector Board
Aegean Exporters' Associations (EİB), Chairperson of the Board of Directors of Aegean Apparel Exporters' Association, Türkiye

Jak ESKİNAZİ
Aegean Exporters' Associations (EİB), Coordinator Chairperson
Chairperson of the Board of Directors of Aegean Textile and Raw Materials Exporters' Association, Türkiye

Ahmet ÖKSÜZ
Istanbul Textile and Raw Materials Exporters' Association (ITHIB), Chairperson of the Board of Directors of Istanbul Textile and Raw Materials Exporters' Association, Türkiye

Ahmet Fikret KİLECİ
Türkiye Exporters Assembly (TIM), Deputy Chairperson
Chairperson of the TIM Textile and Raw Materials Sector Board
Southeast Anatolian Exporters' Associations (GAIB), Coordinator Chairperson
Chairperson of the Board of Directors of Southeast Anatolian Textile and Raw Materials Exporters' Association, Türkiye

*** Opening speeches can be updated*

OPENING PRESENTATION

E. Perrin AKÇAKOCA KUMBASAR, *Chairperson of IITAS 2023 Organizing Committee*
THE DEVELOPMENT OF TEXTILE INDUSTRY IN THE REPUBLIC OF TÜRKIYE

PANEL:
OPPORTUNITIES AND THREATS FOR THE TURKISH TEXTILE AND APPAREL INDUSTRY ON THE 100TH ANNIVERSARY OF THE REPUBLIC

MODERATOR

E. Perrin AKÇAKOCA KUMBASAR
Chairperson of IITAS 2023 Organizing Committee

PANELISTS

Ahmet Fikret KİLECİ
Türkiye Exporters Assembly (TIM), Deputy Chairperson
Chairperson of the TIM Textile and Raw Materials Sector Board
Southeast Anatolian Exporters' Associations (GAIB), Coordinator Chairperson
Chairperson of the Board of Directors of Southeast Anatolian Textile and Raw Materials Exporters' Association, Türkiye

Ahmet ÖKSÜZ
Istanbul Textile and Raw Materials Exporters' Association (ITHIB), Chairperson of the Board of Directors of Istanbul Textile and Raw Materials Exporters' Association, Türkiye

Burak SERTBAŞ
Vice Chairperson of the TIM Apparel Sector Board
Aegean Exporters' Associations (EİB), Chairperson of the Board of Directors of Aegean Apparel Exporters' Association, Türkiye

Muzaffer Turgut KAYHAN
Vice Chairperson of the Board of Directors of Aegean Textile and Raw Materials Exporters' Association, Türkiye

Hayati ERTUĞRUL
Aegean Clothing Manufacturers Association (EGSD), Chairperson of the Board

Hüseyin KADOĞLU
Ege University Textile Engineering Department

20:00 DINNER

OCTOBER 26, THURSDAY

08:30 - 09:30 REGISTRATION

PLENARY SESSION

CHAIR: Hüseyin KADOĞLU, *Ege University, Türkiye*

09:30 - 10:00 **Savvas VASSILIADIS,** *University of West Attica, Greece*
TEXTILE BASED TRIBOELECTRIC GENERATORS

10:00 - 10:30 **Ender YAZGAN BULGUN,** *Izmir University of Economics, Türkiye*
TEXTILE AND FASHION TRENDS; INNOVATION AND BEYOND

10:30 - 11:00 COFFEE BREAK

CHAIR: Arzu MARMARALI, *Ege University, Türkiye*

11:00 - 11:30 **Mirela BLAGA,** *Gheorghe Asachi University of Iasi, Romania*
EDUCATION FOR SUSTAINABLE DEVELOPMENT IN TEXTILES

11:30 - 12:00 **Chokri CHERIF,** *Technische Universität Dresden, Germany*
REVOLUTIONIZING THE CONSTRUCTION INDUSTRY BY USING CARBON CONCRETE COMPOSITES RESOURCE-FRIENDLY - SLENDER CONSTRUCTION - BEAUTY

12:00 - 13:30 LUNCH

	SESSION I	SESSION II	SESSION III
	CHAIR: **Nida OĞLAKCIOĞLU** *Ege University, Türkiye*	CHAIR: **İsmail USTA** *Marmara University, Türkiye*	CHAIR: **Ayşegül KÖRLÜ** *Ege University, Türkiye*
13:30 - 13:50	**Ümit Halis ERDOĞAN** *Dokuz Eylül University, Türkiye* PRODUCTION AND CHARACTERIZATION OF MICROCRYSTALLINE CELLULOSE PARTICLES FROM CELLULOSIC FIBER WASTES	**Mehmet TOPALBEKİROĞLU** *Gaziantep University, Türkiye* THE COATING OF POLIACRILONITRILE STRIP WITH NANOFIBERS PRODUCED BY ELECTROSPINNING	**Hale KARAKAŞ** *Istanbul Technical University, Türkiye* ECO-FRIENDLY DENIM WASHING PROCESS
13:50 - 14:10	**Neslihan OKYAY** *Karacasu Tekstil, Türkiye* BRINGING SUSTAINABLE FIBER FROM STEM, LEAF AND FOOD PRODUCT WASTE TO RING SPINNING TECHNOLOGY	**Seniha MORSÜMBÜL** *Ege University, Türkiye* TEA TREE OIL LOADED NANOFIBERS FOR WOUND DRESSING APPLICATIONS	**Eylen Sema DALBAŞI** *Ege University, Türkiye* DESIGN AND DEVELOPMENT OF MULTIFUNCTIONAL FABRIC USING COATING METHOD WITH DIFFERENT FINISHING PROCESSES
14:10 - 14:30	**Ebru ÇALIŞKAN** *Baykan Denim R&D Center, Türkiye* AN INVESTIGATION ON THE EFFICIENCY OF AN IN-HOUSE FABRIC RECYCLING LINE UTILISATION FOR PRE-CONSUMER DENIM WASTES	**Yeşim ÜNVAR** *Dokuz Eylül University, Türkiye* EXPANDING OPPORTUNITIES WITHIN THE UV PROTECTION OF ARAMID FIBERS: MATERIAL INDEPENDENT LBL TECHNOLOGY	**Ayşe GENÇ** *Çalık Denim Tekstil San. Tic. A.Ş., Türkiye* THE OPTIMIZATION STUDY ON TREATMENT OF DENIM FABRICS WITH SOL-GEL METHOD
14:30 - 14:50	**Esra GÜNEŞ** *SANKO Textile R&D Center, Türkiye* EFFECT OF RING YARN MACHINE SPINNING ELEMENTS ON RECYCLE YARN PRODUCTION	**Fabien SALAÜN** *University of Lille - ENSAIT, France* PCL PHOTO-RESPONSIVE ELECTROSPUN MEMBRANE BASED ON PHOTOCHROMIC MOLECULE	**Kübra SABANCI KAPUKAYA** *Maritaş Denim San. Tic. A.Ş, Türkiye* THE EFFECT OF USING GRAPHENE IN DENIM FABRICS ON THERMAL PERFORMANCE CHARACTERISTICS
14:50 - 15:10	**Buket GÜLER** *TYH Uluslararası Tekstil Pazarlama A.Ş., Türkiye* SPORTSWEAR COLLECTION DEVELOPED FROM PULP BASED BIODEGRADABLE REGENERATED CELLULOSE FIBERS	**Gizem Ceylan TÜRKOĞLU** *Dokuz Eylül University, Türkiye* INVESTIGATION OF THE PVA SOLUTIONS PROPERTIES ON THE ELECTROSPINNING MAT	**Ferhan GEBEŞ** *ORMO Yün İplik San. Tic. A.Ş., Türkiye* MACHINE MODIFICATION TO SOLVE COLOR CONTAMINATION PROBLEM IN YARN PRINTING MACHINES
15:10 - 15:30	**Alper DİKTAŞ** *SERKON Teknoloji A.Ş & AĞTEKS Ltd. Türkiye* DIGITALIZATION AND AI APPLICATIONS FROM YARN TO GARMENT	**Mert IŞILAY** *Ege University, Türkiye* PROPERTIES OF NANOFIBROUS POLY(VINYL ALCOHOL)/NAFION POLYMER ELECTROLYTE MEMBRANES	**Abdulkadir ERÇAKALLI** *Kıvanç Textile, Türkiye* A STUDY ON REDUCING THE COLOR DIFFERENCE BETWEEN DYEING IN THE LABORATORY AND DYEHOUSE

15:30 - 16:00 COFFEE BREAK

	CHAIR: A. Merih SARIIŞIK, Dokuz Eylül University, Türkiye	CHAIR: Pınar ÇELİK, Ege University, Türkiye	CHAIR: Hale KARAKAŞ, İstanbul Technical University, Türkiye
16:00 - 16:20	**Çiğdem AKDUMAN** *Pamukkale University, Türkiye* SUSTAINABLE PREPARATION OF PROCESS WATER: A CASE STUDY OF DOUBLE REVERSE OSMOSIS IN A TEXTILE DYEHOUSE	**Selçuk POYRAZ** *Adıyaman University, Türkiye* MICROWAVE ENERGY-BASED APPROACH TO PREPARATION AND CHARACTERIZATION OF FUNCTIONAL TEXTILES FOR FIBER REINFORCED POLYMERIC COMPOSITES	**Dilara SEVİNDİK** *Dokuz Eylül University, Türkiye* SUSTAINABLE DYEING PROCESS OF PET FABRICS BY USING IONIC LIQUIDS
16:20 - 16:40	**Hüseyin KARIŞLI** *Erka Mühendislik Ltd. Şti., Türkiye* CLEANER PRODUCTION PRACTICES IN THE TEXTILE SECTOR	**Merve TURAN** *Çalık Denim Tekstil San. Tic. A.Ş., Türkiye* A NEW METHOD IN PRODUCTION OF MULTI-COMPONENT HYBRID YARN AND YARN PROPERTIES	**Seda KESKİN** *Eren Retail & Textile Inc R&D Center, Türkiye* INVESTIGATION OF BLEACHING AND DYEABILITY OF KNITTED FABRICS BY FOAM APPLICATION METHOD
16:40 - 17:00	**Gözde ABACI** *Can Tekstil Entegre Tesisleri ve Tarım Ürünleri San. Tic. A.Ş., Türkiye* INVESTIGATION OF MICROPLASTIC IN WATER AND WASTEWATER SAMPLES IN ERGENE REGION - EXAMPLE OF AN INTEGRATED TEXTILE MILL	**Çağla Deniz ŞENTÜRK** *SANKO Textile and Trading Corporation & Ege University, Türkiye* A RESEARCH ON PROPERTIES OF KNITTED FABRICS PRODUCED WITH RING AND ROTOR-SPUN YARNS CONTAINING RECYCLED COTTON FIBER	**Hüseyin TOPÇU** *Dok-San Denizli Textile Industury and Trade Inc. R&D Center, Türkiye* DEEP LEARNING-BASED CONVOLUTIONAL NEURAL NETWORKS FOR ROTARY SCREEN PIGMENT PRINTING MACHINE PARAMETER ESTIMATION
17:00 - 17:20	**Murat ONAN** *Onan Kimya Tekstil San. ve Tic. Ltd. Şti., Türkiye* NEW OPPORTUNITIES FOR PES FIBRE IN TERMS OF DYEING AND PRINTING	**Kerim KILINÇ** *Polyteks Tekstil San. Araş. Eğit. A.Ş., Türkiye* INVESTIGATION OF UV RESISTANCE PROPERTIES OF BICOMPONENT YARNS PRODUCED WITH DIFFERENT ADDITIVES	**Selenay Elif İŞLER** *Martur Fompak International, Türkiye* EVALUATION OF THE TECHNICAL PERFORMANCE OF AUTOMOTIVE SEAT FABRICS PRODUCED USING POCKET STRUCTURES AND FILLER YARN
17:20 - 17:40	**Özgür CEYLAN** *Eskişehir Technical University, Türkiye* ECO-FRIENDLY DENIM THROUGH THE COLORS OF NATURE	**Christopher JOHNEN** *Saurer Group, Germany* AUTOAIRO - THINK PROGRESS WITH SAURER´S NEW AIR SPINNING MACHINE	**Şafak BİROL** *TYH İzmir R&D Center, Türkiye* DIGITAL TRANSFORMATION AND ITS EFFECTS ON PRODUCTIVITY IN A CLOTHING COMPANY
17:40- 18:00	**Tuğce TÖNGÜÇ YALÇINKAYA** *Ege University, Türkiye* WOOL BASED ACTIVATED CARBON FIBERS FOR CARBON DIOXIDE CAPTURE	**Türkan Kübra BAYKAN** *SANKO Textile R&D Center, Türkiye* THE EFFECT OF YARNS MADE FROM DIFFERENT FIBER BLENDS ON QUALITY VALUES	**Deniz YAZICI** *ATT Clothing, Türkiye* ADVANCED DIGITAL TECHNOLOGIES IN FASHION DESIGN
15:00 - 17:00	AUTEX GENERAL ASSEMBLY (AUTEX MEMBERS ONLY)		
18:00 - 19:00	MEETING OF TEXTILE ENGINNERING DEPARTMENTS OF TÜRKİYE (ONLY CHAIRPERSON OF THE DEPARTMENTS)		
20:00	GALA DINNER - 100TH ANNIVERSARY OF THE REPUBLIC OF TÜRKİYE		

OCTOBER 27, FRIDAY

08:30 - 09:30	REGISTRATION
	PLENARY SESSION
	CHAIR: Savvas VASSILIADIS, *University of West Attica, Greece*
09:30 - 10:00	**Lieva VAN LANGENHOVE,** *Ghent University, Belgium* ENHANCING THE USE OF REUSABLES AT HOSPITALS
10:00 - 10:30	**Andrej DEMŠAR,** *University of Ljubljana, Slovenia* HOLISTIC THINKING AND ACTING
10:30 - 11:00	COFFEE BREAK
	CHAIR: Mirela BLAGA, *Gheorghe Asachi University of Iasi, Romania*
11:00 - 11:30	**Vladan KONCAR,** *University of Lille - ENSAIT- GEMTEX, France* HOW TO IMPROVE THE QUALITY AND RELIABILITY OF E-TEXTILE SYSTEMS - STANDARDS
11:30 - 12:00	**Yordan KYOSEV,** Technische Universität Dresden, Germany FROM GEOMETRIC MODELING TO SIMULATION OF THE HAPTICS OF TEXTILE PRODUCTS - OPEN MODELING QUESTIONS
12:00 - 13:30	LUNCH

	SESSION I	SESSION II	SESSION III
	CHAIR: Ümit Halis ERDOĞAN, Dokuz Eylül University, Türkiye	CHAIR: Y. Dilek KUT, Bursa Uludağ University, Türkiye	CHAIR: Seher KANAT, Ege University, Türkiye
13:30 - 13:50	**Cevza CANDAN** *Istanbul Technical University, Türkiye* ARTIFICIAL INTELLIGENCE BASED ASSESSMENT AND OPTIMISATION OF KNITTED FABRICS SUITABLE FOR ALLERGIC INDIVIDUALS	**Funda GÖKSEL** *TÜBİTAK Bursa Test and Analysis Laboratory, Türkiye* A STUDY ON THE EFFECT OF ABRASIVE TYPE ON THE PILLING PERFORMANCE OF PLAIN AND BLENDED FABRICS	**Nevin Çiğdem GÜRSOY** *Istanbul Technical University, Türkiye* UNIVERSAL TEXTILE DESIGN CENTER

13:50 - 14:10	**Serdar BAŞEV** *Spinteks Tekstil San. Tic. A.Ş., Türkiye* THE EFFECT OF DIFFERENT FABRIC CONSTRUCTIONS ON BUILDING REINFORCEMENT	**Nazire YILMAZ** *Uşak University, Türkiye* EFFECT OF THERMAL TREATMENTS ON HYGROSCOPIC PROPERTIES OF BIOLOGICALLY DEGUMMED OKRA BAST FIBERS	**Mehmet KERTMEN** *İskur Tekstil Enerji Tic. San. A.Ş., Türkiye* PASSIVE SMART CELLULOSIC KNITTED FABRICS WITH ENHANCED PERMEABILITY AND ABSORPTION FEATURES
14:10 - 14:30	**Bilge KOYUNCU** *DeepTech Engineering Ltd., Türkiye* DESIGN OF A DRYSUIT WITH IMPROVED THERMAL MANAGEMENT PROPERTIES FOR COLD WATER APPLICATIONS	**Yasemin DÜLEK** *SYK Textile R&D Center, Türkiye* OPTIMIZATION OF THE PARAMETERS INFLUENCE BLEACHING PROCESS FOR NETTLE/COTTON MIXED FABRICS BY TAGUCHI METHOD	**Gökçe SAKMAR** *Zorluteks Textile Trade and Industry Inc., Türkiye* DEVELOPMENT OF A PRODUCTION SYSTEM FOR BLEACHING MACHINES INDEPENDENT OF HUMAN CONTROL AND AIMING THE RIGHT PRODUCTION AT ONCE
14:30 - 14:50	**Ahmed EL SHAFEI** *North Carolina State University, USA* SUSTAINABLE DYEING OF COTTON USING ZERO SALT AND ZERO ALKALI WITH ZERO EFFLUENT	**Mehmet KERTMEN** *İskur Tekstil Enerji Tic. San. A.Ş., Türkiye* ENVIRONMENTAL IMPACTS OF 100% VIRGIN COTTON AND RECYCLED COTTON/VIRGIN COTTON BLENDED FABRICS	**Olena KYZYMCHUK** *Kyiv National University of Technologies and Design, Ukraine &* *Technische Universität Dresden, Germany* THE PRESSURE CHARACTERISTICS OF ELASTIC WARP KNITTED FABRICS
14:50 - 15:10	**Aristeidis REPOULIAS** *University of West Attica, Greece* UTILIZING PTFE FILAMENT TO ACHIEVE EFFICIENCY AND AESTHETICS IN WEARABLE TRIBOELECTRIC GENERATORS	**Benamir FİDANCI** *Martur Fompak International, Türkiye* A STUDY ABOUT THE CORRELATION BETWEEN SEAM FATIGUE AND STATIC FRICTION TESTS FOR AUTOMOTIVE UPHOLSTERY CIRCULAR KNITTED FABRICS	**Sema BAHAR ERDEM** *Dokuz Eylül University, Türkiye* THE IMPORTANCE OF FIBER TYPE AND COLOR IN THE ENVIRONMENTAL EFFECTS OF GARMENTS
15:10 - 15:30	**Aylin Saadet TOKYÜREK** *Ege University, Türkiye* A HYDROGEL/TEXTILE BASED ACTUATOR FOR SOFT ROBOTIC APPLICATIONS	**Merve YARALI** *Menderes Textile Industry and Trade Inc. R&D Center, Türkiye* ENVIRONMENTAL AND SUSTAINABLE 100% COTTON FABRIC PRODUCTION FROM FIBERS OBTAINED FROM FINAL CONSUMER TEXTILE WASTES	**Esra TAŞTAN ÖZKAN** *Bitlis Eren University, Türkiye* THE EFFECT OF DIFFERENT STRUCTURAL PARAMETERS AND WASHINGS ON THERMAL PROPERTIES OF DENIM FABRICS
15:30 - 16:30	**POSTER SESSION & COFFEE BREAK**		
	CHAIR: **Selçuk POYRAZ** *Adıyaman University, Türkiye*	**CHAIR:** **Ahmet ÇAY** *Ege University, Türkiye*	**CHAIR:** **Ebru BOZACI** *Ege University, Türkiye*
16:30 - 16:50	**Esra TAŞTAN ÖZKAN** *Bitlis Eren University, Türkiye* THE EFFECT OF PCM ON THE SURFACE TEMPERATURE OF TIGHT GARMENTS AND SUBJECTIVE COMFORT EVALUATIONS	**Olena KYZYMCHUK** *Kyiv National University of Technologies and Design, Ukraine &* *Technische Universität Dresden, Germany* THE ADVANCED TECHNOLOGY FOR COMPRESSION GARMENT DESIGN	**Edit CSANÁK** *Óbuda University, Hungary* SUSTAINABLE FASHION: A HISTORICAL REVIEW
16:50 - 17:10	**Bilge KOYUNCU** *DeepTech Engineering Ltd., Türkiye* HEAT ON-THE-GO: DESIGN OF A BABY BOTTLE WARMER BAG WITH A TEXTILE-BASED HEATER SYSTEM	**Merve BULUT** *Istanbul Technical University, Türkiye* INFLUENCE OF COPET DISSOLUTION AND DYEING PROCESSES ON PHYSICAL PERFORMANCE OF BLACKOUTS FROM PET/COPET BICOMPONENT YARNS	**Anne-Marie GRUNDMEIER** *University of Education Freiburg, Germany* FASHION DIET - CHALLENGES AND POTENTIALS OF OPEN EDUCATIONAL RESOURCES (O ER) FOR EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) IN TEXTILE EDUCATION
17:10 - 17:30	**Nataliya SADRETDINOVA** *Kyiv National University of Technologies and Design, Ukraine & Technische Universität Dresden, Germany* IMPLEMENTATION OF MODERN DYNAMIC APPROACH IN GARMENT PATTERN DESIGN FOR DEAF PEOPLE	**Chaimae ZOUHRI** *University Med V & Center of Excellence in Logistics (CELOG), Morocco & ESITH & University of Monastir, Tunisia* THE APPLICATION OF ARTIFICIAL INTELLIGENCE FOR ASSEMBLY LINE BALANCING IN THE CLOTHING INDUSTRY	**İsmail İVEDİ** *ROTEKS Tekstil İhr. San. Tic. A.Ş., Türkiye* REVOLUTIONIZING SEWING MACHINES: ANALYZING THE INTEGRATION OF BOBBIN THREAD DETECTION DEVICES
17:30 - 17:50	**Oumaima CHAJII** *Faculty of Sciences Ben M'sik - University of Hassan II, Technical Center of Textile and Clothing (CTTH), Casablanca, Morocco* NEW APPROACH TO DYE EXTRACTION FROM RUBIA TINCTORUM AND RESEDA LUTEOLA PLANTS	**Seher KANAT** *Ege University, Türkiye* THE EFFECTS OF STORE WINDOW DESIGN ON CLOTHING BUYING BEHAVIOR	**Hanieh CHOOPANI** *University of Education Freiburg & University of Applied Sciences and Arts Hannover, Germany* EXPLORING EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) IN FASHION DESIGN STUDIES IN GERMANY AND IRAN - A COMPARISON
17:50 - 18:10	**Elifsu Hazal MORGÜL** *Ege University, Türkiye* TEXTILE REINFORCED CONCRETE: A COMPREHENSIVE REVIEW	**Aslıhan KABAŞ** *Ege University, Türkiye* THE USE OF RECYCLED COTTON FIBERS FOR SUSTAINABLE TEXTILE PRODUCTION	
18:10	**CLOSING**		

**IITAS 2023 Organizing Committee has the rights to make any changes on the programme.*

XVI[th] INTERNATIONAL IZMIR TEXTILE AND APPAREL SYMPOSIUM

25-27 October 2023

Altın Yunus Hotel, Çeşme - izmir

POSTER PRESENTATIONS of IITAS 2023

POSTER PRESENTATION LIST

Alphabetical Order of Surnames

1. **AKGÜL Y.İ.,** *İPEKİŞ MENSUCAT TÜRK A.Ş, TÜRKİYE*
   IMPROVING THE FUNCTIONAL PROPERTIES OF WOOL / POLYAMIDE BLEND UPHOLSTERY FABRIC
2. **ARAS ELİBÜYÜK S.,** *OZANTEKS TEKSTIL, TÜRKİYE*
   INVESTIGATION OF IMAGE DEFECTS CAUSED BY PILE LOSS OF TOWEL FABRIC
3. **ARDIÇ KURT B.,** *CAN TEKSTIL ENTEGRE TESISLERI VE TARIM ÜRÜNLERI SAN. TIC. A.S., TÜRKİYE*
   INVESTIGATION OF RAW MATERIAL SOURCES EFFECT ON GREENHOUSE GAS EMISSIONS IN WOVEN FABRIC MANUFACTURING MILL
4. **BALABAN F.Ç.,** *ZORLUTEKS TEXTILE TRADE AND INDUSTRY INC., TÜRKİYE*
   DEVELOPMENT OF SUSTAINABLE CONVEYOR BELT FABRIC ALTERNATIVE TO RUBBER CONVEYOR BELTS
5. **ČUK N.,** *UNIVERSITY OF LJUBLJANA, SLOVENIA*
   INFLUENCE OF THE WEAVING STRUCTURE PARAMETERS ON THE WETTABILITY OF THE LINEN FABRICS
6. **ÇELİK P.,** *EGE UNIVERSITY, TÜRKİYE*
   HEMP AND COTTON AS A NATURAL FIBER
7. **DEMİR GÜNENÇ Ö.,** *OZANTEKS TEKSTIL, TÜRKİYE*
   DEVELOPMENT OF MULTIFUNCTIONAL OUTDOOR FABRICS USING ACRYLIC YARN
8. **ERTOĞRUL E.,** *EGE UNIVERSITY, TÜRKİYE*
   ANTIBACTERIAL PROPERTIES OF NEEDLE-PUNCHED NONWOVENS FOR MEDICAL APPLICATIONS
9. **GLAŽAR D.,** *UNIVERSITY OF LJUBLJANA, SLOVENIA*
   Ag, TiO2 AND GRAPHITIC CARBON NITRIDE COMPOSITES FOR THE PREPARATION OF PHOTOCATALYTICALLY ACTIVE COTTON FABRIC
10. **KESİCİ Ş.,** *TYH TEXTILE R&D CENTER, TÜRKİYE*
    SLOW FASHION AND MODULAR DESIGN: IMPROVE SUSTAINABILITY AND VERSATILITY IN TEXTILE PRODUCTS
11. **KOSTAJNŠEK K.,** *UNIVERSITY OF LJUBLJANA, SLOVENIA*
    DESIGN AND DEVELOPMENT OF A JACQUARD FABRIC FOR ZERO-WASTE GARMENTS
12. **MARTIN A.,** *EKSOY KİMYA, TÜRKİYE*
    SUBLIMATION FASTNESS INVESTIGATION OF POLYESTER FABRICS TREATED WITH HYDROPHILIC SILICONE EMULSION
13. **ONUKTAV O.,** *SUN TEKSTIL SANAYI VE TICARET A.Ş., TÜRKİYE*
    NEW TECHNOLOGIES TO INTEGRATE PLASTIC WASTE IN THE CIRCULAR
14. **ÖZDİL N.,** *EGE UNIVERSITY, TÜRKİYE*
    PROTECTIVE CLOTHING: STANDARDIZATION AND CERTIFICATION
15. **ÖZKAVRUK ADANIR E.,** *IZMIR UNIVERSITY OF ECONOMICS, TÜRKİYE*
    BRIDGING CREATIVITY AND TECHNOLOGY: STITCHING IMAGINARY IZMIR FROM ANCIENT TIMES TO AI
16. **PAVKO ČUDEN A.,** *UNIVERSITY OF LJUBLJANA, SLOVENIA*
    MULTI-PURPOSE KNITTED BABY WRAP
17. **PAVKO ČUDEN A.,** *UNIVERSITY OF LJUBLJANA, SLOVENIA*
    FASHION, TECHNOLOGY AND SUSTAINABILITY IN CONTEMPORARY KNITTING
18. **SAKAN E.,** *FG TEKSTIL KONFEKSIYON SAN. TIC. A.Ş., TÜRKİYE*
    DEVELOPMENT OF OZONE EFFECTING SYSTEM WITHOUT USING HARMFUL CHEMICALS
19. **ŞEN YUVAYAPAN S.,** *AK-KIM KIMYA SAN. VE TIC. A.Ş, TÜRKİYE*
    ECO-FRIENDLY, SUSTAINABLE APPROACH TO DENIM WASHING PROCESS
20. **TİRYAKİ GÜZEL S.,** *MARMARA UNIVERSITY, TÜRKİYE*
    AN INVESTIGATION OF ELECTROMAGNETIC SHIELDING EFFECTIVENESS PROPERTIES OF POROUS STRUCTURE IN NON-WOVEN FABRICS
21. **YILDIZ S.,** *ÇUKUROVA UNIVERSITY & BOSSA DENIM COMPANY, TÜRKİYE*
    DENIM ART
22. **YÜKSEL C.,** *AK-KIM KIMYA SAN. VE TIC. A.Ş, TÜRKİYE*
    LOW TEMPERATURE BLEACHING OF COTTON FIBER BY NOVEL CATALYST

**IITAS 2023 Organizing Committee has the rights to make any changes on the programme.*

CONTENTS

**The content is arranged alphabetically according to the surname of the first author in three groups: plenary, oral and poster presentations.*

ABSTRACTS OF PLENARY PRESENTATIONS

EDUCATION FOR SUSTAINABLE DEVELOPMENT IN TEXTILES

Mirela Blaga[1], Anne-Marie Grundmeier[2]
[1]*"Gheorghe Asachi" Technical University of Iasi, Romania,*
[2]*University of Education Freiburg, Freiburg, Germany*
mblaga@tex.tuiasi.ro, grundmeier@ph-freiburg.de

INTRODUCTION

Recent innovations in textiles have much to do with the need to address the problems associated with current overconsumption and related environmental issues. As a result, the industry is currently focusing on producing multifunctional, high-quality products with durable designs and longer life spans in line with the demand for sustainability in the textile and apparel sector. The textile and apparel industry focuses on reuse, recycling, recovery of raw materials, and partial or total elimination of textile waste [1].

All textile education stakeholders are working to develop programmes that reflect the modernity of these industries and the wide variety of career opportunities they offer today. With the aim of developing sector-specific skills solutions, the European Commission's New Skills Agenda launched the Blueprint for Sectoral Cooperation on Skills as a framework for developing strategic cooperation between key stakeholders in each sector of the economy (companies, education and training institutions, research institutes, public authorities) [2]. The upcoming transformation of the textile and fashion industry towards sustainability therefore requires the continuous implementation of the guiding principle of Education for Sustainable Development (ESD) in education and training. The term Education for Sustainable Development is defined in the UNESCO Roadmap for the Implementation of the Global Action Programme *'Education for Sustainable Development'*, as follows: ESD empowers learners to make informed choices and act responsibly to protect the environment, sustain the economy and create a just society for current and future generations, while respecting cultural diversity [3].

EU FASHIONDIET PROJECT OUTCOMES

In this context, team members of the EU project "Sustainable Fashion Curriculum at Textile Universities in Europe-Development, Implementation and Evaluation of a Teaching Module for Educators", FashionDiet, have developed a series of 42 lectures focusing on the latest textile-related ESD and sustainability aspects of the four project partners, as shown in Figure 1 [4]. The aim of this paper is to present the results of the project in the form of lectures developed to improve the key competencies of lecturers, teachers, trainers, students and young textile specialists. The presentations are intended by the authors as learning opportunities for teachers, not necessarily as ready-made lectures. The teaching and learning materials are made available as Open Educational Resources on the Moodle platform Glocal Campus [5].

The first part of the module, "Didactic and methodological implementation of ESD", is aimed primarily at lecturers, teachers and trainers in vocational education and their students as further employees in the textile and fashion industry – who are also consumers. In the outlook, beliefs, knowledge as well as their impact on teaching, learning and importance for ESD are discussed. In this sense, topics such as: from the triple bottom line of sustainability to more advanced aspects in the context of textiles and fashion, education for sustainable development, as a

guiding principle in the context of fashion and textiles, research-based learning in the context of textile education, design thinking – a suitable method for implementing education for sustainable development in textile education, sustainability-oriented consumer education in fashion and textiles, empathy, mindfulness and ethical values in fashion consumption, overcoming the growth dilemma – rational collective economy, are presented.

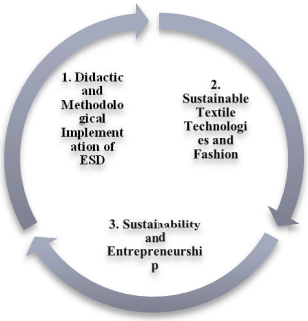


Figure 1: Structure of the ESD Module [4]

The second pillar, entitled "Sustainable Textile Technologies and Fashion," covers aspects such as: sustainable raw materials, sustainable knitting production, dyeing, printing and finishing in the context of sustainability, fashion design in the context of sustainable development of the fashion and textile industry, pattern making in the context of sustainability, best practices of sustainable product development through 3D design and visualization and examples of slow fashion projects.

The third pillar, called “Sustainability and Entrepreneurship," focuses on issues related to: fashion consumption in the European market, consumer research, impact of e-commerce and media on sustainable fashion, global supply chains for textiles and apparel, international sourcing of textiles and apparel for the European retail market, social risk management in fashion supply chains, and others such as: opportunities and risks of slow fashion strategies and a circular economy in the European market.

Keywords: Education for Sustainable Development, Textiles, E-learning.

ACKNOWLEDGEMENTS
This research was co-funded by the EU Erasmus+ Programme, through the Project “Sustainable fashion curriculum at textile Universities in Europe-Development, Implementation and Evaluation of a Teaching Module for Educators”, FashionDiet, 2020-1-DE01-KA203-005657.

REFERENCES

[1] Pavko Cuden A., Recent developments in knitting technology, book chapter in: Maity, S. Advanced Knitting Technology, Elsevier, 2022, pp. 13–66.
[2] https://s4tclfblueprint.eu/project/tclf-sectors/european-clothing-industry
[3] German Commission for UNESCO (Ed.). (2014). *Roadmap zur Umsetzung des Weltaktionsprogramms „Bildung für nachhaltige Entwicklung“* [Roadmap for the implementation of the World Programme of Action "Education for Sustainable Development"]
[4] https://fashiondiet.eu/
[5] https://glocal-campus.org/login/altlogin/index.html

REVOLUTIONIZING THE CONSTRUCTION INDUSTRY BY USING CARBON CONCRETE COMPOSITES
- RESOURCE-FRIENDLY - SLENDER CONSTRUCTION – BEAUTY -

Chokri Cherif
Technische Universität Dresden, Institute for Textile Machinery and High Performance Technology, Dresden, Germany
chokri.cherif@tu-dresden.de

Textile reinforcements made of high performance filament yarns in the form of biaxial or multiaxial open-grid fabrics, esp. carbon, offer high strength and stiffness along the fiber direction due to their stretched filament layers and flexible arrangement possibilities of the reinforcing yarns. In addition, they are characterized by high handling capability and excellent chemical resistance. The recent research in the field of structural reinforcements and repair have shown that textile open-grid fabric structures made of carbon yarns can act as reinforcement in concrete and provide an excellent alternative to the existing concrete reinforcement and repair methods. The fundamental work for the development and production of such textile reinforcements have been carried out during many years of research at the Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden and reflects the current state-of-the-art on an international scale. The scientific knowledge gained by this research was gradually put into practice. The founding of the organisations German Center for Textile Concrete, Tudalit e.V., TUDATEX GmbH and CarboCon GmbH is yet another result of their hard work. Also, the technical expertise acquired at the ITM enables to produce application adapted, high performing textile reinforcements with the help of modern and highly productive multiaxial warp knitting machines under industrial conditions as well. This includes the transfer of technologies for textile manufacturing and coating applications into serial production realized by textile manufacturers including textile mechanical engineers and plant manufacturers as well as the application in concrete constructions and structure components by the construction industry, see fig. 1.

Figure 1. Repair of hyper shell structure in Schweinfurt (Source: TU Dresden)

The essential foundation for applications of textile reinforcements in the building industry was created due to the first building control certification for textile-reinforced concrete by the brand TUDALIT®, at the German Institute for Construction Technology. Core elements of this certification are textile concrete-reinforcements, consisting of Carbon Fiber Heavy Tows and rovings.

Meanwhile, these textile reinforcements have found industrial markets and must comply with strictly defined quality criteria. The involved companies have received general construction approval as well and are now comercially available.

On the subject of carbon concrete, the Dresden professors Manfred Curbach, Chokri Cherif and Peter Offermann have won the German Future Prize 2016. The German President Joachim Gauck has awarded the Prize on November 30th in Berlin. The team of researchers was among the three finalists and thus able to prevail against its competitors (Mercedes and BMW). For the first time in history, the prize has been awarded to a team in the fields of textile and civil engineering. This proves the importance of interdisciplinary research to achieve the necessary paradigm shift in the building industry – moving towards resource efficiency and sustainablility. The German Future Prize is one of the most significant science prizes in Germany.

The building industry is one of the most important branches of the European economy. Its level of innovation will have a significant influence on whether Germany succeeds in fulfilling its climate goals - the reduction of CO2 emissions, energy saving and resource conservation. With the exception of water, concrete is the most-used raw material, with approximately 5 billion m^3. Concrete is composed of cement, sand, gravel and water. 1.6 billion tonnes of cement, 10 billion tonnes of sand and gravel aggregate, and one billion tonnes of water are used in the development and retrofitting of buildings and bridges every year. Thereby, every tonne of cement generates over half a million tonnes of CO2. The immense amount of material required causes the building industry to be one of the largest emitters of CO2 and responsible for around 40% of energy consumption. Using carbon concrete means we can build with thinner walls, which requires less cement, sand, gravel and water, and furthermore reduces transport costs.

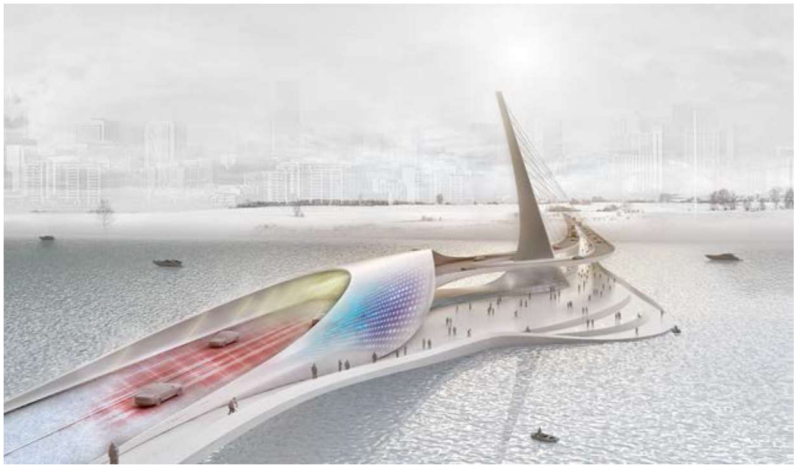


Figure 2. Multifunctional buildings (Source: TU Dresden)

Being a durable and resource efficient composite material, carbon concrete combines strength with flexibility and multi-functionality, making construction maintenance and future

construction economical, ecologically sustainable and attractive. "Lightweight building" and "concrete" is no longer a contradiction. The relatively small thickness of the building components allows for a finer and more appealing building style. Thus, it is possible to gain more interior space whilst maintaining the size of the exterior. The flexible but extremely high strength carbon fabric is easy to process and, due to its enhanced durability, is as suitable as reinforcing material.

Furthermore, carbon concrete creates new opportunities for new constructions, building retrofitting and strengthening. This innovative building material allows for extremely thin but highly efficient strengthening layers in concrete constructions and is particularly suited to complex boundary conditions and the preservation of historical buildings.

Future research will focus on further developing textile reinforcements with regard to larger cross-sectional areas up to rod structures, and significantly improving the composite behavior of the concrete matrix regarding force transmission mechanisms and thermal resistance. Carbon concrete can be used in the future to insulate heat or monitor buildings with additional functions. The lifetime of buildings, bridges and masts can be increased significantly by applying a thin layer of carbon concrete. Since 2006, old and new buildings, such as the barrel vaults in Zwickau, as well as huge silos, such as the Zuckersilos in Uelzen, have been reinforced as described. Characterized by a very good price-performance-ratio and fulfilling highest demands regarding strength and quality, textile reinforcement not only creates the conditions for the success of the entire textile-concrete technology, but also paves the way for an unlimited and market-wide use of reinforcement textiles in the construction industry. The Construction Industry will be revolutionized through Carbon Concrete Composites.

Keywords: Multiaxial Warp Knitting, Textile reinforced Concrete, Civil Engineering

.

HOLISTIC THINKING AND ACTING

Andrej Demšar[1], Matija Svetina[2], Marko Pavliha[3]
[1] *University of Ljubljana / Faculty of Natural Sciences and Engineering / Department of Textiles, Graphic Arts and Design*
[2] *University of Ljubljana / The Faculty of Arts / Department of Psychology*
[3] *University of Ljubljana / Faculty of Maritime Studies and Transport*
andrej.demsar@ntf.uni-lj.si

The contribution presents the course "Holistic thinking and acting", which will begin to be implemented in the school year 2023/24 at the Faculty of Natural Sciences and Technology of the University of Ljubljana. The content of the course is focused on the student with the aim of developing competences in the field of student's profession. Holistic and transdisciplinary thinking and the integration of natural science and technology knowledge with social science and humanities knowledge is encouraged. The basic guideline of the course is to focus on the student and on the development of the student's competencies with the help of holistic, critical and transdisciplinary thinking.

The fundamental goal of the course is to develop students' independent, open and integrated thinking, whose mission is to work for the benefit of the wider social community. Holistic, transdisciplinary and critical thinking about systems, their interconnections and the consequences of their operation will be encouraged; connecting natural science and technology knowledge with social science and humanities knowledge; creation of new models, approaches, solutions and visions through critical consideration and a holistic approach; thinking about today with a view to yesterday, today and tomorrow.

The expansion of the student's view of the environment and society and the complexity of their connection is expected. Holistic, transdisciplinary and critical thinking provides insight into the complexity of relationships in the world and encourages listeners to make more responsible and sustainable decisions.

Keywords: Holism, education, sustainability, change

[1] DEMŠAR, A., ANEJA, A. Bending the curve: a holistic approach to technology education. 16th Autex Conference, Proceedings. June 8-10. Ljubljana, Slovenia. (2016).
[2] DEMŠAR, A., ANEJA, A. Value of values: a new pedagogical paradigm. 15th Autex Conference, Proceedings. June 10–12. Bucharest, Romania. (2015).
[3] SVETINA, M. The Microgenetic Approach in the Digitalised Era in Cognitive Development from a Strategy Perspective. Routledge (2018).
[4] SVETINA, M., ZUPANČIČ, M. Life management strategies in adulthood:
A cross-sectional study in Slovenia. Horizons of Psychology, 16, 4, 43-63 (2007).
[5] PAVLIHA, M. Dvanajst pred dvanajsto ali Za norost je zdravilo modrost:eseji o iskanju svetlobe. Umco. (2014).
[6] PAVLIHA, M. Onkraj materialističnega prepričanja: duhovna dramila. (2021).

HOW TO IMPROVE THE QUALITY AND RELIABILITY OF E-TEXTILE SYSTEMS - STANDARDS

Vladan Koncar
ENSAIT – GEMTEX, University of Lille, France

ABSTRACT

Over the last few years, the smart textiles market has rapidly expanded due to the advancement and implementation of IoT technologies. According to a report by Markets and Markets, the global smart textiles market is expected to be worth more than US$3 billion by 2026.

Currently, heated clothing represents one of the most successful smart textiles markets. This technology has a relatively mature value chain and well-established manufacturing practices, with examples dating back to the early 20th century. Heated textiles are largely being applied to sportswear, motorcycling apparel, workwear, and thermotherapy devices.
Another area of the market that has a lot of potential is physiological monitoring, which is gaining popularity at an impressive rate. This technology allows users to monitor health and performance parameters such as heart rate, respiratory rate, muscle activity, sweat, and temperature, as well as tracking movement and location. It has received a lot of interest from the sports and fitness and the healthcare sectors, where the majority of R&D is being carried out. The Covid-19 pandemic has undoubtedly increased this trend, as this technology is helping to bridge the gap between physical care and virtual care, enabling healthcare providers to overcome the barriers of social distancing through remote monitoring and diagnostic solutions. As the e-textile market continues to grow, comparable quality and reliability standards across the multitude of e-textile applications become a necessity.

Thus far, there are no proper e-textile reliability standards, so e-textile manufacturers look to other, related fields where such standards already exist. Faced with the unique challenge of combining two worlds – electronics and textiles – with often very different materials, properties, and requirements, those standards often fail to meet e-textile specific needs. This situation resulted in the efforts to establish the standard IPC 8981 Quality and Reliability for E-Textiles Wearables, starting back in 2019 with a survey among industry and research stakeholders.
This survey aimed at gaining insight into which quality and reliability characteristics (mechanical like bending or abrasion resistance or exposure like temperature or UV resistance) were deemed important for different application areas for e-textiles (fashion, sports, medical, military).
This survey also aimed at gaining insight into which quality and reliability characteristics (mechanical like bending or abrasion resistance or exposure like temperature or UV resistance) were deemed important for different application areas for e-textiles (fashion, sports, medical, military).
Thus, the drafts of test methods including mechanical and exposure stresses and the master documents containing the threshold values enabling the classification of e-textile products in 3 classes are currently finalized and will be published in 2024.
The standards recognize that textile-based electrical and electronic assemblies (E-Textile Wearables) are subject to classifications by intended end-item use. Three general end-product classes have been established to reflect differences in manufacturability, complexity, functional

performance requirements, and verification (inspection/test/laundering) frequency. It should be recognized that there may be overlaps of product between classes.

CLASS 1 General E-Textile Wearables

Includes products suitable for application categories where the major requirement is function of the completed assembly.

CLASS 2 Dedicated Purpose E-Textile Wearables

Includes products where continued performance and extended life is required, and for which uninterrupted service is desired, but not critical. Typically, the end-use environment would not cause failures.

CLASS 3 High Performance/Harsh Environment E-Textile Wearables

Includes products where extended-lifetime, high reliability and performance or performance-on-demand are critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

This standard also recognizes CLASS 2 and CLASS 3 products that may be designed to be disposable after one- or short-time use. Requirements specific to these product use cases are identified in this standard.

FROM GEOMETRIC MODELING TO SIMULATION OF THE HAPTICS OF TEXTILE PRODUCTS - OPEN MODELING QUESTIONS

Yordan Kyosev[1], **Anselm Naake**[2]
[1] *TU Dresden / Institute of Textile Machinery and High Performance Material Technology / 01062 Dresden*
yordan.kyosev@tu-dresden.de

The haptic feeling (touch) of textile products is a complex process, depending on the interaction between the human finger and the textile product (stimulus) and the processing of the resulting nervous excitations by the brain (perception). The perception does not only depend on the stimuli, but also individual traits like age, personality or culture. In some cases, the haptic properties of textiles are purposefully engineered [1]. Generally, selecting the materials and designing the surfaces for certain haptic qualities is part of product design. The evaluation of the touch (or "handle") properties is a complex process, requiring samples, testing humans or special testing devices. Some researchers apply image processing techniques [2] to analyze the surface, some companies apply TSA analysis based on sound (Fa. Emtec, Germany). Still, the most useful and reliable method is the evaluation by humans, often done in expert panels. The data of this evaluation can be analyzed by fuzzy logic systems [3], or described by single numbers.

As of now (2023), a common numerical evaluation of the surface is not reported – largely because of the complexity of the textile products. Textile fabrics are superstructures consisting of two substructures: Fabrics consist of yarns and yarns consist of fibers. Both substructures may determine the haptic perception depending on their material properties and orientation. The fiber orientation in the yarns and other products is studied by B. Neckar [4], who provides mathematical background for the analysis. Some implementations of the theory for ply yarns are done for observation of the yarn cross section shape [5]. In the last years, these models became implemented in software, where the fibers and their position in the yarns are modelled in the 3D space [6]. The modelling of the fabrics structure at yarn level is well developed and examples can be seen in works for warp knitting [7,8].

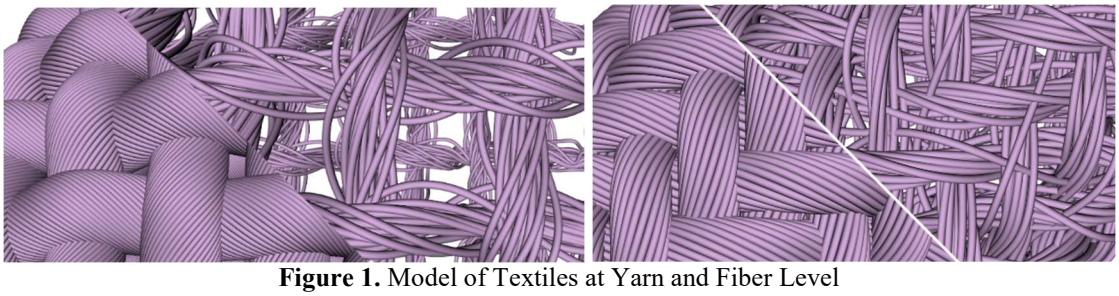


Figure 1. Model of Textiles at Yarn and Fiber Level

In order the hairiness of the yarns to be modelled, the fibers have to be represented correctly [9]. Figure 1 demonstrates plain and twill weave, modelled initially (left hand side) of twisted multifilament yarns. The positions of the filaments in these surfaces are after that randomized using normal distribution and then the yarn surface receive more natural appearance (the right parts of the both images). Once the structure of the yarns at fiber level is correctly modelled, this can be exported and used for FEM modelling of the sensing process by the human fingers

and used for evaluation of the haptics of the structures. The open issues in this process will be reported in detail during the conference.

Keywords: haptics, modelling, geometric modelling, textiles, touch

[1] ALMENDARIZ , D., NIELSEN, N. M., & DESCHL, L. (2023). Pressure-point-garments: haptic stimulation of the body enabled through a fashionable 3D-textile interface. *Communications in Development and Assembling of Textile Products*, *4*(2), 201-212. https://doi.org/10.25367/cdatp.2023.4.p201-212

[2] BLACHOWICZ, T. ., & KORUSZOWIC, M. (2021). Evaluation of the surface quality of spun materials using topothesy. *Communications in Development and Assembling of Textile Products*, *2*(2), 208-216. https://doi.org/10.25367/cdatp.2021.2.p208-216

[3] REINERS P., KYOSEV Y., AND MÜNKS D., Investigation of the variety of the human textile sensation of the textile fabrics as preparation for the building of fuzzy expert system. In: *XIIth International Izmir Textile and Apparel Symposium*.,2010

[4] NECKÁŘ B, DAS D AND ISHTIAQUE SM. A mathematical model of fiber orientation in slivers. *Journal of the Textile Institute* 2012; 103: 463–476.

[5] GRISHANOV SA, LOMOV SV, HARWOOD RJ, et al. The Simulation of the Geometry of Two-component Yarns. Part I: The Mechanics of Strand Compression: Simulating Yarn Cross-section Shape. *Journal of the Textile Institute* 1997; 88: 118–131.

[6] AYCHILIE DB, KYOSEV Y and ABTEW MA. Automatic Modeller of Textile Yarns at Fibre Level. *Materials (Basel)* 2022; 15. **https://doi.org/10.3390/ma15248887**
Kyosev, Y., Topology-Based Modeling of Textile Structures and Their Joint Assemblies, Springer, 2019, https://doi.org/10.1007/978-3-030-02541-0

[7] LIU, H., KYOSEV, Y., & JIANG, G. (2022). Yarn level simulation of warp-knitted clothing elements – first results and challenges. *Communications in Development and Assembling of Textile Products*, *3*(2), 115-126. https://doi.org/10.25367/cdatp.2022.3.p115-126

[8] KYOSEV Y., From geometrical modelling to simulation of touch of textile products - open modelling issues, in 12. SAXON SIMULATION MEETING : Präsentationen und Vorträge des 12. Anwendertreffens am 7. März 2023 an der Technischen Universität Chemnitz, Chemnitz, 7 March, 2923, https://doi.org/10.51382/978-3-96100-112-5_v10
[9] KYOSEV Y., Topology-Based Modeling of Textile Structures and Their Joint Assemblies Principles, Algorithms and Limitations, Springer, 2019, https://doi.org/10.1007/978-3-030-02541-0

ENHANCING THE USE OF REUSABLES AT HOSPITALS

Lieva Van Langenhove[1], Benny Malengier[1], Abreha Bayrau Nigusse[1]
[1]*Ghent University/ Materials, Textiles and Chemical Technology (CTSE)/Technologiepark 70A, Ghent (Belgium)*
Lieva.VanLangenhove@ugent.be

INTRODUCTION

Textile products find many applications in the medical field. They cover a very broad range of fibre types, textile structures, and functionalities. The market is expected to reach 23.3 billion US dollars by 2025 representing an annual growth rate of more than 6% [1]. Almost one third are disposables [2]. Consequently, this market has a huge potential to increase sustainability.

However many factors stand in the way of switching from disposables to reusables. This concerns price, cleaning, washing, decontamination, logistic handling, just to name some.
Yet compared to disposables, reusables could be more comfortable and include intelligence. Overall, technical, financial, and psychological factors have to be considered to enhance the use of reusables at the hospital.

The Flemish project reCURE [3] aims to elaborate a roadmap towards smart reusable high quality care products. The project includes a part on mapping the use of textiles at the operation theatre from the different points of view. Ghent University focuses on the value added by improved comfort and introduction of smart textiles, whereas the University of Antwerp studies the practical factors related to using both disposables and reusables. Case studies in collaboration with industry are to demonstrate the feasibility and added value of switching to reusables.

Comfort is a very broad concept. It includes thermophysiological well-being, ease to move, and psychological factors such as look and feel. Comfort is in line with SDGoal 3 (Health and Well Being). In addition, in the setting of an operation theatre specific regulations may apply, such as how to put on a surgical gown, in view of sterility of the materials. This paper will focus on thermophysiological comfort.

EXPERIMENTAL

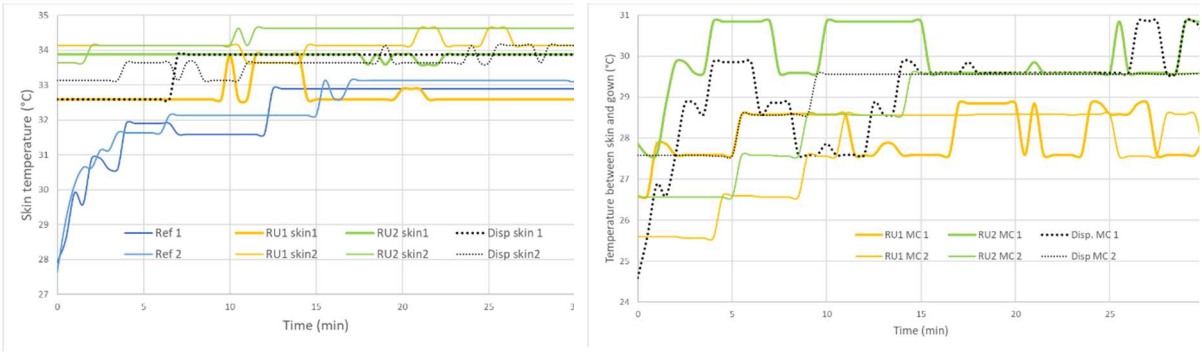
Two types of commercial reusable surgical gowns and one standard disposable surgical gown were included in this study (Table 1).

Table 1. Composition of the gowns

Product	Basic fabric	Composition	Critical fabric
Disposable	Non woven 73g/m²	PET - wood pulp	PE film 110g/m²
Reusable 1	Plain weave 127 g/m²	PET - Carbon	Plain weave 145 g/m²
Reusable 2	Plain weave 110 g/m²	PET - Carbon	Plain weave 134 g/m²

Reusable gowns being significantly heavier than disposable ones, one can expect their thermophysiological comfort to be inferior. To determine the comfort of the surgical gowns, the temperature at the skin and in the space between the gown and the skin (micro climate MC) was measured, while performing standard tasks. As a reference, the test was repeated with

standard clothes. These temperatures reflect both thermophysiological and ergonomic comfort. DS1923 iButtron data loggers were used to collect temperature and humidity.
Figure 1 shows the skin (a) and microclimate (b) temperature of a test person wearing reference clothes, two types of reusable gowns (RU1 and 2) and one disposable (Disp), measured at the front (index 1) resp. at the back (index 2).



(a) (b)

Figure 2. Skin and microclimate temperature (a resp. b); index 1 resp. 2 means values measured at the front resp. back of the Subject

The skin temperature is higher than the microclimate temperature, which is to be expected. Wearing a gown does not have a dramatic effect on skin temperature, especially after some time. Reusable gowns do not lead to higher temperatures than disposable ones. The reusable gowns leading to different temperatures indicates that by optimising the reusable gowns, by improving the design they can offer a better comfort than disposable ones.

CONCLUSIONS

In order to increase the sustainability of medical textiles, reducing the use of disposables is a key factor. The reCURE project demonstrates the feasibility and added value of switching from disposables to reusables. Now the project focuses on further in depth measurements and optimisation of the gowns.
Comfort is a major added value of reusable textile products. Both thermophysiological and ergonomic comfort can be improved for reusable products, thus contributing to higher degree of acceptance. More research is needed to validate the findings and to document and quantify comfort in view of its introduction in LCA models in order to assess its impact on sustainability.

Keywords: medical textiles, reusables, comfort, handprint

[1] https://www.marketsandmarkets.com/Market-Reports/healthcare-fabric-market-220548133.html?gclid=EAIaIQobChMIp8_Khv6mgQMVnJmDBx3p4AeNEAAYASAAEgIAXfD_BwE, visited on September 13th 2023
[2] https://www.marketwatch.com/press-release/latest-report-2023-on-disposable-medical-textiles-market-share-by-2031-survey-by-absolute-reports-2023-06-17, visited on September 13th 2023
[3] https://www.uantwerpen.be/nl/projecten/reuse-lab/projecten/onderzoeksprojecten/recure/ visited on September 13th 2023

TEXTILE BASED TRIBOELECTRIC GENERATORS

S. Vassiliadis, A. Repoulias
University of West Attica, Department of Electrical and Electronic Engineering

Triboelectricity is a phenomenon observed many centuries ago. It has found limited technological applications. Recently increased research interest is observed due to the ability of the development of triboelectric generators in a very small scale resulting in the Triboelectric Nano Generators (TNG). The small scale allows the use of these devices in micro and nano scale mechanisms. The wearable devices, which are continuously developed, have as permanent presupposition for their operation the delivery of electrical power. Traditionally, the power is delivered from batteries or other power storage devices. However, these parts and their necessary connectors introduce a certain difficulty during the washing and care procedures. The replacement of the consumable batteries with other alternative power sources is an open research topic. One very promising alternative is the use of triboelectric generators, able to provide the necessary power for the operation of the wearable devices.

The efficiency of the triboelectric generators depends mainly on the combination of the materials used as active elements and on the mechanical stimulation characteristics. Thorough research work in parallel to the development of specially designed and dedicated measuring devices resulted in the detection of the most suitable combination of materials and mechanical stimulation modes. The success of a Triboelectric Nano Generator depends on the electrical voltage and power produced, as well as on the density of the power if the factor of its volume is considered as an important factor.

The textile based Triboelectric Nano Generators are well suited for wearable applications. They use textile fabrics as active triboelectric elements and thus they can be easily integrated in a clothing item. From the experimental work done, it has been found that the selection of the fibrous material plays a significant role as well as the textile structural parameters affect the efficiency of the wearable TNG. Various yarn densities in knitted or woven fabrics affect the surface characteristics of the fabrics and especially its surface roughness. It is important to design the experiment considering the size as well as the load application range imposed by the clothes dimensions and the mechanical behavior of the human body. The method used and the results of the recent research work is presented in the current communication.

TEXTILE AND FASHION TRENDS, INNOVATION AND BEYOND

Ender Yazgan Bulgun, Filiz Özbengi Uslu
Izmir University of Economics
ender.bulgun@ieu.edu.tr

The textile and fashion industry is undergoing a transformative phase, characterized by a myriad of emerging trends and technologies. The industry has shown remarkable resilience in the wake of the COVID-19 pandemic, with significant growth recorded in 2021 and the first half of 2022. However, geopolitical tensions and macroeconomic instabilities, particularly the war in Ukraine and subsequent energy crises, have introduced new complexities [1]. Despite challenges, the industry is using tech innovations to adapt to change. The COVID-19-driven shift to remote work is expected to last through 2024, boosting growth in casual and athletic wear. Therefore, categories such as casual wear, athletic wear, and athletic footwear are expected to experience the most significant growth [2]. Amidst looming economic uncertainties, sustainability initiatives are identified as the most significant opportunity for the next year [3]. In accordance with these insights, it is evident that the textile and fashion industry is currently situated at a critical turning point. At this turning point, the current and forthcoming trends embraced by the sector are identified and listed in this study with a comprehensive literature review (Figure 1).

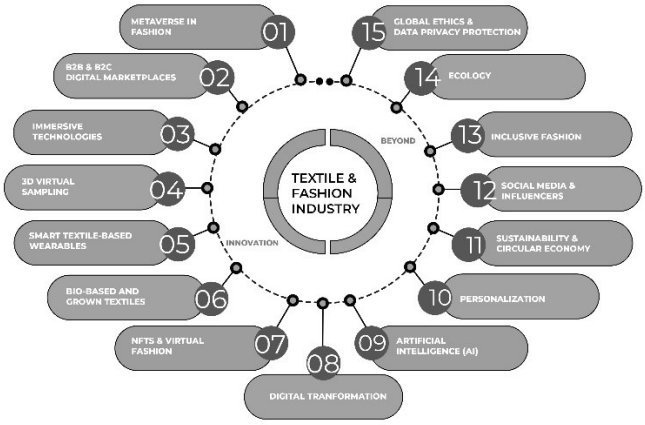


Figure 1. Current textile and fashion industry trends

Emerging technologies such as the metaverse are revolutionizing the way fashion is showcased and consumed, offering virtual spaces for interactive experiences and provide a potential for fashion brands to create immersive experiences and build communities. The advent of immersive technologies has been a transformative force in the fashion industry, it emphasized the use of immersive technologies such as AR and VR in reducing online returns, educating consumers, and reducing waste in design and production [4]. 3D virtual sampling is a cutting-edge technology in the fashion and textile industry that allows designers and manufacturers to create, visualize, and test designs in a digital environment before producing physical samples and helps to digitize garment patterns, reduce human errors, save time, and accelerate the business work cycle. Innovations such as smart textiles are gaining traction for their multifunctional capabilities and represent a fusion of style and technology. It is becoming clear that clothing manufacturers need to incorporate smart textile fibers into garments to meet consumers' demands for individual expression and technological elements. The industry is also witnessing the rise of bio-based and grown textiles that contribute to sustainability which had

USD 900 million market share in 2022 and is projected to exhibit over 3% CAGR from 2023-2032 [5]. Digital transformation initiatives, including the application of artificial intelligence in design and supply chain management, are making companies more agile. Personalization strategies, facilitated by data analytics, are enabling more tailored consumer experiences, while sustainability and circular economy models are becoming increasingly central to the brand ethos. The role of social media and influencers in shaping consumer behavior is significant, offering both opportunities and challenges for brands. Inclusion and diversity are also gaining attention, both from a social and economic standpoint and brands are increasingly examining the changing representation of disability in fashion media, recognizing that online platforms offer unique opportunities for diversity and inclusion. Ecological considerations in the fashion industry have achieved significant attention in recent years, driven by consumer awareness, regulatory changes, and the urgent need to address environmental degradation in relation to both sustainability and digitalization. Navigating through the complex landscape of emerging trends, technologies, and ethical considerations, the textile and fashion industry is at a pivotal juncture, as evidenced by the comprehensive literature review conducted in this study. This review has illuminated fifteen key areas that are shaping the industry's trajectory, from the metaverse's immersive experiences to the ethical imperatives of data privacy. In this study, Izmir University of Economics, Faculty of Fine Arts and Design projects are also presented that are creating change in a rapidly evolving field by serving as a microcosm of larger industry trends. As we transition from this overarching analysis to a more specialized focus, it is pertinent to highlight three fundamental thematic areas that encapsulate the tendency of the industry: digitalization, smartness, and sustainability. These themes serve as the linking points through which the most transformative and innovative work in fashion and textiles is currently revolving.

In conclusion, this study shows that the textile and fashion industry is in the midst of a profound transformation, marked by a confluence of technological innovations, shifting consumer preferences, and ethical imperatives. These pivotal elements are not merely reactive measures to extant challenges but represent a proactive engagement with future possibilities.

Keywords: Fashion Trends, Technological Innovations, Sustainability, Resilience

[1] BOF. The state of fashion 2023. McKinsey & Company, 2022, p 10.

[2] VEIGA, P. DIOGO, J. Consumer behavior: a literature review of the early research on the covid-19 outbreak. International Journal of Marketing, Communication and New Media, 2022, vol. 11, pp. 62-91.

[3] FANDRAJEWSKA, A., CHMIELARZ, W., ZBOROWSKI, M. The impact of the covid-19 pandemic on the perception of globalization and consumer behavior. Sustainability, 2022, vol. 14, no. 15: 9575.

[4] AKHTAR, W. H., WATANABE, C., TOU, Y., & NEITTAANMÄKI, P. A new perspective on the textile and apparel industry in the digital transformation era. Textiles, 2022, vol. 2, no. 4, pp. 633-656.

[5] MANSHOVEN, S. VERCALSTEREN, A. CHRISTIS, M. DE JONG, A. SCHMIDT, I. GROSSI, F. TENHUNEN, A. and FOGH MORTENSEN, L. ETC CE Report 2023/8 consumption and the environment in europe's circular economy. updated 13.06.2023 [cited 06.10.2023]. Available on https://www.eionet.europa.eu/etcs/

ABSTRACTS OF ORAL PRESENTATIONS

INVESTIGATION OF MICROPLASTIC IN WATER AND WASTEWATER SAMPLES IN ERGENE REGION – EXAMPLE OF AN INTEGRATED TEXTILE MILL

Gözde Abaci [1], **Günay Yildiz Töre** [2], **Can Burak Özkal** [3]
[1] *Can Tekstil Entegre Tesisleri ve Tarım Ürünleri San. Tic. A.S. Ergene-2 OSB D-100 No:45/1 59930, Ergene-Tekirdag, Turkiye*
[1,2,3] *Tekirdağ Namık Kemal University, Çorlu Engineering Faculty, Environmental Engineering Department, 59860, Tekirdag, Turkiye*
abacigozde@gmail.com

ABSTRACT
Recent scientific studies on water, which is the most important source of living things, focus on microplastic pollution. Microplastics are plastic residues in very different shapes, smaller than 5 mm, and although it is seen as the most serious environmental problem in water resources, waste water, soil and air, although national and international regulation has not been adopted on microplastic pollution yet. This study, which characterizes microplastics in groundwater samples taken from Ergene Basin and process wastewater from an integrated textile mill, is a pioneering research in the sector in terms of microplastic determination.

Keywords: microplastics, textile wastewater, method evaluation, microscopic analysis, FTIR analysis

INTRODUCTION
As a result of decomposition by physical, photodegradation, chemical or enzymatic factors plastics in nature sun, water, air, etc., it mixes with soil, water, air and participates in the food chain by changing its physical properties (such as shape, color, crystallinity and density). With by their surface area and pore size, they also adsorb other toxic chemicals, and the amount they adsorb tends to be higher in naturally aged plastics [1]. Microplastic pollution is a parameter that has started to be monitored relatively late compared to other pollutants, especially in domestic and industrial wastewater. Especially the hydrophobic hazardous chemicals that microplastics can contain show that microplastics are a carrier pollution source especially for the aquatic ecosystem [2]. Although there is no internationally valid method for the determination of microplastics, scientists have developed many physical and chemical determination methods in the face of this pollution that threatens all living things globally. Examples of physical methods are sieving, filtration, visual separation, separation by density difference; separation with the aid of acidic, basic or other chemicals, enzymatic separation and analytical methods are examples of chemical methods such as SEM/EDS, FTIR, NIR, Raman spectrophotometry and NMR [1, 3, 4]. In a study, it was determined that the most abundant microplastics in different WWTP wastewater were polyester terephthalate fibers and polyethylene particles. With the study, they reported the microplastic removal efficiency as 92-99% by weight as a result of primary, secondary and tertiary treatment. It has been emphasized that more attention should be paid to secondary source synthetic fibers obtained from textile products compared to microbeads from primary source personal care products [2].

METHOD/ANALYSIS
In this study, water samples from groundwater and wastewater samples from woven fabric dyeing and finishing processes, which are supplied from integrated textile mill in Ergene Region, were taken as composite samples in 5 liter volumes. Although there are many primary

treatment methods for the separation of microplastic residues in wastewater samples in the literature, the catalytic Wet Peroxide Oxidation (WPO) method has been preferred because of its effective and fast oxidation time[5]. The water and wastewater samples were treated according to the wet oxidation-chemical method as given in Masura protocol [6], filtered under a vacuum pump using a nylon filter according to the filtration-physical method, and the filter papers were examined under a light microscope (LEICA DM750). FTIR (Thermo Fisher Scientific Nicolet IS 10 FTIR) analyzes of raw water and untreated wastewater samples were also completed.

RESULTS AND DISCUSSION

Detection of microplastic pollution in water and raw wastewater originating from fabric dyeing finishing processes in an integrated textile mill operating in Ergene Basin producing woven fabrics is considered as a pioneering study. The detected microplastics were supported by microscope analysis and FTIR analysis. The presence of fiber and microplastic was detected in all samples. Microplastic concentration was mostly determined in process wastewater and in the form of polyethyleneterephthalate-based filaments.

CONCLUSION

The rapid increase in the use of synthetic raw materials together with the increasing consumption in the textile industry in recent years also significantly affects the microplastic pollution. It should be aimed to detect this pollution with detailed analyzes on process (source) basis and to prevent pollution with research and development studies. These studies will serve as a guide for industrial enterprises for the national/international requirements that are planned to be implemented in the near future.

REFERENCES

[1] TIRKEY, A. Upadhyay, L.S.B. Microplastics: An overview on separation, identification and characterization of microplastics. Marine Pollution Bulletin, 2021, vol. 170, no. 112604, ISSN 0025-326X, https://doi.org/10.1016/j.marpolbul.2021.112604.

[2] TUTOĞLU, N. (2019). Sucul ortamdaki mikroplastiklerin insan sağlığına etkisi ve arıtma yöntemlerinin araştırılması (Uzmanlık tezi). T.C. Tarım ve Orman Bakanlığı Su Yönetimi Genel Müdürlüğü, Ankara, Türkiye.

[3] DIERKES, G., LAUSCHKE, T., FÖLDI, C. (2021). Analytical Methods for Plastic (Microplastic) Determination in Environmental Samples. In: Stock, F., Reifferscheid, G., Brennholt, N., Kostianaia, E. (eds) Plastics in the Aquatic Environment - Part I. The Handbook of Environmental Chemistry, vol 111. Springer, Cham. https://doi.org/10.1007/698_2021_744

[4] ZARFL, C. Promising techniques and open challenges for microplastic identification and quantification in environmental matrices. Anal Bioanal Chem 411, 2019, 3743–3756. https://doi.org/10.1007/s00216-019-01763-9.

[5] TURAN, N. B., ERKAN, H.S., ENGIN G.O. Microplastics in wastewater treatment plants: Occurrence, fate and identification, 2021, Process Safety and Environmental Protection, Volume 146, Pages 77-84, ISSN 0957-5820, https://doi.org/10.1016/j.psep.2020.08.039.

[6] MASURA, J., et al. 2015. Laboratory methods for the analysis of microplastics in the marine environment: recommendations for quantifying synthetic particles in waters and sediments. NOAA Technical Memorandum NOS-OR&R-48.

PCL PHOTO-RESPONSIVE ELECTROSPUN MEMBRANE BASED ON PHOTOCHROMIC MOLECULE

Mahad Barre Aden[1], **François Rault**[1], **Fabien Salaün**[1]
[1] Univ. Lille, ENSAIT, ULR 2461 - GEMTEX - Génie et Matériaux Textiles, F-59000 Lille, France
fabien.salaun@ensait.fr

Smart textile structures based on photochromic molecules have received increasing attention in recent years due to their enormous potential for applications to detect and respond to external environmental conditions and stimuli [1]. Functionalization enables the design of textile substrates to block UV light or detect environmental changes, which can be used for security printing in clothing, for fashion purposes, or higher value-added products such as fabric-based electronic displays, anti-counterfeiting codes, or solar sensor and heating systems. Nevertheless, the functionalization of textiles with inorganic and organic pigments generally poses problems during application due to their low thermal and light stabilities. There is a need to further improve textiles' manufacturing processes and formulation to provide more efficient functionality. To achieve this goal, the electrospinning process to produce photosensitive membranes as smart materials has shown promising results in many application areas [2, 3]. Photochromic dithienylethene (DTE) derivatives as photochromic pigments are interesting since these compounds stand out most for their outstanding thermal stability, rapid photoresponse, and excellent fatigue resistance under a light stimulus. Moreover, in addition to the light-responsive, the design and construction of efficient multi-stimuli responsive switches have attracted numerous studies [4].

In this work, poly(ε-caprolactone) (PCL, 37,000 g/mol) photo-responsive electrospun membranes based on DTE photochromic molecule (1,2-bis(2,3-dimethyl-5-phenyl-3-thienyl)-3,3,4,4,5,5-hexafluoro-1-cyclopentene) were prepared to study the influence of the formulation parameters on the photo response. First, the solvents were selected based on the Hansen solubility parameters. The effect of the chloroform to N, N-Dimethylformamide ratio, PCL concentration (8 to 30 wt/v %), and DTE concentration ($3.6x10^{-3}$ to $43.8x10^{-3}$ mol/L) were studied. Furthermore, a first-order kinetic model was used to describe the kinetic behavior of the color change for the photochromic samples under UV and visible light stimulus (Figure 1) (Eq. (1)).

$$\Delta\frac{K}{S} = \left(\frac{K}{S0} - \frac{K}{S\infty}\right).e^{(-k.t)} + \frac{K}{S\infty} \quad (1)$$

Where, K is the absorption coefficient, S is the scattering coefficient, k is the rate constant, and t is the time (second).

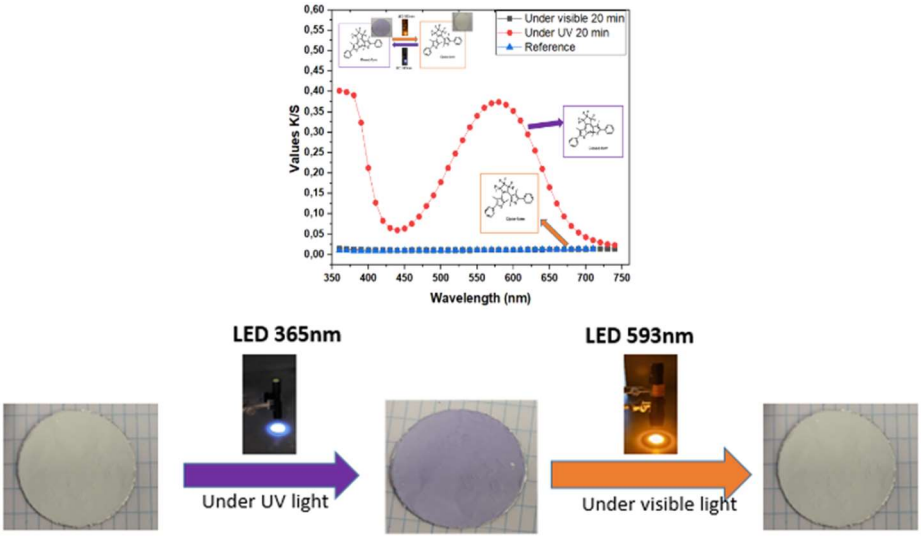


Figure 1. Evaluation of the photochromic response

From previous experiments, a set of parameters was the most accurate and repeatable regarding fiber diameter distribution and stable jetting without dripping from the syringe tip. Parameters such as distance from the needle to the collector defined at 20 cm and a flow rate of 0.7 mL/h at 20 kV were selected. All solutions were used immediately after preparation to avoid the aging effect.

Without taking into account the intensity of the color, which is a function of the DTE concentration in the system, it also appears that the kinetic parameters of color change (colorless->colored and colored->colorless) are closely related to the DTE concentration. The different samples show excellent reversibility during more than 20 cycles of color change, indicating a good diffusion of DTE molecules within the PCL matrix during the electrospinning process and good stability of the obtained electrospun membranes.

Keywords: photo-responsive membrane, electrospinning, diarylethene, color change kinetic model

[1] SAYEB, S., DEBBABI, F., HORCHANI-NAIFER, K. Investigation of photochromic pigment used for smart textile fabric. Optical Materials, 2022, vol 128, pp 112393.
[2] LIU, M.-N., YAN, X., YOU, M.-H., FU, J., NIE, G.-D., YU, M., NING, X., WAN, Y., LONG, Y.-Z. Reversible photochromic nanofibrous membranes with excellent water/windproof and breathable performance. Journal of Applied Polymer Science, 2018, vol. 135, no. 23, pp 46342.
[3] BAO, B., FAN, J., XU, R., WANG, W., YU, D. Rewritable Spiropyran/Polyacrylonitrile Hybrid Nanofiber Membrane Prepared by Electrospinning. Nano, 2020, vol. 15, no. 01, pp 2050013.
[4] YAN, Q., QIAO, Z., XU, J., REN, J., & WANG, S. All-visible-light triggered photochromic fluorescent dithienylethene-phenanthroimidazole dyads: Synthesis, crystal structure, multiple switching behavior and information storage. Dyes and Pigments, 2022, vol. 202, pp. 110298.

SUSTAINABLE PREPARATION OF PROCESS WATER: A CASE STUDY OF DOUBLE REVERSE OSMOSIS IN A TEXTILE DYEHOUSE

Cigdem Akduman
Pamukkale University / Denizli Vocational School of Technical Sciences, Department of Textile Technology, 20100, Denizli, Turkey
cakduman@pau.edu.tr

The textile industry is one of the longest and most complex industrial production/supply chains in the manufacturing industry [1]. Besides, it is one of the largest consumers of water and chemicals for wet processing of textiles [2]. The textile industry uses water for the generation of steam, for removing impurities, applying dyes, and finishing agents. Therefore, successful results in the textile wet processing are strongly dependent on the quality of water.

Natural and pre-treated water may contain a variety of chemical species that can influence textile wet processing in general and dyeing in particular [3]. Unreliable, inconsistent and/or contaminated incoming water have a major effect on the repeatability of dyeing and the quality of goods. Hard water causes the dyes to precipitate with the hardness components during the alkali fixation stage and therefore soft water should be used in all dissolving and dyebath processes [4]. Wash off processes are less effective with hard water and lead to poor wash and rub fastness. The alkalinity in water can also act as a buffer and make it difficult to achieve the extremes of pH required for reactive dyeing. Sources of water with variable bicarbonate content can adversely affect the reproducibility of the dye fixation conditions [4]. Thus, dye houses need a consistent supply of soft water or the ability to soften water on-site. Consistent and uncontaminated process water ensures on-time delivery in a cost-effective way. To ensure production is as consistent as possible, high-water quality should be maintained, monitored on-line and off-line and records retained as part of quality management systems. Today, resin (ion exchange) or reverse osmosis systems can be used depending on the character of the raw water to be treated and the purity of the water to be obtained, or it is possible to use the two as complementary systems. Ion exchange involves removing the hardness ions calcium and magnesium and replacing them with non-hardness ions, typically sodium supplied by dissolved sodium chloride salt. It is reversible, and regeneration simply involves treatment with a concentrated solution of a salt containing the appropriate anion [3]. On the other hand, reverse osmosis (RO) is a technology that is used to remove a large majority of contaminants from water by forcing the water to pass through a semi-permeable membrane under pressure [5] and provide high and consistent process water. However, main drawbacks of RO are, high initialisation cost, fast fouling of the membranes and significant water waste during the purification.

In this study ion exchange and RO systems are explained, general water consumption of these systems are summarized. Then, a dyehouse example is given and analysed which uses an ion exchange systems and double RO system. Ion exchange systems is used for pre-softening of the municipal water, and it prevents the fast fouling of RO membranes. Second RO system is used for recycling the waste water from first RO and ion exchange systems in order to reduce the total water waste. First RO system generates approximately 30-35% of waste water and second RO system process both first RO and ion exchange system's waste and recover approximately 50-55% back. This lead approximately 13% of total waste which is much higher than single RO system. Finally, together with the modern dyeing equipment and lower liquor

ratios, 55-60 L/kg water consumptions can be achieved. In order to create a sustainable textile production, the main challenge has been linked to lesser usage of water, energy and chemicals in production processes. Double RO systems operated with pre-ion exchange systems will be the sustainable solution for consistent and high-quality process water with lower water waste.

Keywords: Reverse osmosis (RO), Process water, Water consumption, Sustainability

[1] ROTH, J., ZERGER, B., De GEETER, D., GOMEZ BENAVIDES J. and ROUDIER, S., Best available techniques (BAT) reference document for the Textiles Industry, EUR 31392 EN, Publications Office of the European Union, Luxembourg, 2023, ISBN 978-92-76-61945-1, doi:10.2760/355887, JRC131874, p 1029.
[2] PETRINIĆ, I., BAJRAKTARI, N. and HÉLIX-NIELSEN, C. Membrane technologies for water treatment and reuse in the textile industry. In Advances in Membrane Technologies for Water Treatment (pp. 537-550). Woodhead Publishing, 2015.
[3] BROADBENT, A. D. Basic principles of textile coloration Bradford, UK: Society of Dyers and Colorists, (Vol. 132, pp. 332-357). 2001, p 579.
[4] SHORE, J., Chapter 4: Dyeing with Reactive Dyes. In Cellulosic Dyeing, Edited by J.S. Oxford: Society of Dyers and Colourists, 1995, pp 189-244
[5] IDREES, M. F. Performance analysis and treatment technologies of reverse osmosis plant–a case study. Case studies, Chemical and environmental engineering. 2020, vol.2, pp 100007.

ECO-FRIENDLY DENIM WASHING PROCESS

Havva Baskan-Bayrak[1], Hilal Oztürk[2], Basak Cigeroglu[2], Khikmatillo Matkhoshimov[2], Hale Karakas[2]

[1] *Sabanci University Integrated Manufacturing Technologies Research and Application Center & Composite Technologies Center of Excellence, Teknopark Istanbul, Pendik, 34906, Istanbul, Turkey*

[2] *Istanbul Technical University, Textile Technologies and Design Faculty, Gumussuyu, Beyoglu 34437, Istanbul, Turkey*

havva.baskan@sabanciuniv.edu.tr

ABSTRACT

Denim fabric is one of the oldest fabric forms in the world and still remains young as the most important part of the textile industry due to its simplicity, comfort, and durability. However, denim manufacturing requires several chemical and washing processes in order to remove the dye from the fabric, lighten the fabric, give the fabric tensile strength, and remove hardness from it. In addition, denim washing alters the appearance of the garment. This enhanced look can be worn or pale look, more grayscale, or any other shade setting. As the number of chemical processes increases, water and energy consumption increase at the same rate. On the other hand, in the current state, the awareness of sustainability and environmentally friendly production increases rapidly both in the social field and in the industrial sector. The importance of textile products which eco-friendly approved and eco-labeled has improved with the use of eco-friendly chemicals, less water usage and energy consumption, and regulation of the use of natural resources. Therefore, it is needed to lessen the energy, chemical, and water usage in denim manufacturing since denim products are subjected to many washing processes. One of the innovations that reduce water usage in denim manufacturing is the application of ozone technology. This technology eliminates the use of various chemicals in denim washing and does not pollute the environment while providing both economic and ecological benefits by consuming less energy. In this study, denim fabrics made of 99 % cotton and 1 % elastane which were dyed with 7 different dyes were washed with 4 different recipes. In Figure 1, the images of the denim fabrics before washing and color changes in denim fabrics after washing are shown. Ozone technology was used in three recipes. Color fastness to crocking, dimensional stability, tear strength, yarn strength, Martindale abrasion resistance, color fastness to washing, color changes of the obtained denim fabrics were evaluated and compared to each other. When the tests of 28 test samples washed with 4 different prescriptions were compared, positive effects of ozone gas on the physical and fastness properties of the fabrics were observed. Thus, it can be summarized that the usage of ozone technology is successful in denim industry in terms of waste usage, resources, energy and cost.

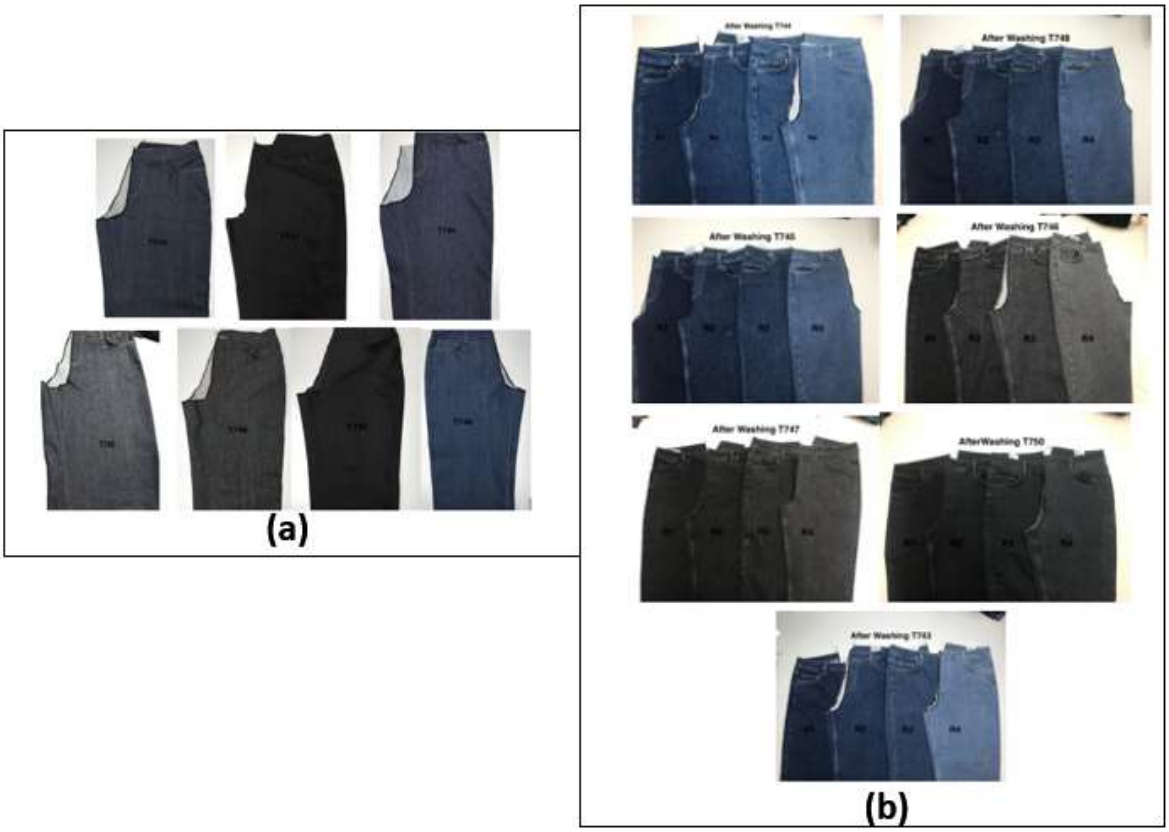


Figure 1. (a) Denim fabrics before washing and **(b)** color changes in denim fabrics after washing.

Keywords: Denim, washing, ozone, sustainability.

[1] AMUTHA, K. Environmental impacts of denim. In Sustainability in denim. Woodhead Publishing, 2017, 27-48.
[2] BLACKBURN, R. Sustainable textiles: life cycle and environmental impact. Elsevier, 2009,14-45.
[3] POWAR, A.S., PERWUELZ, A., BEHARY, N., HOANG, L., and AUSSENAC, T. Application of ozone treatment for the decolorization of the reactive-dyed fabrics in a pilot-scale process—optimization through response surface methodology. Sustainability, 2020, 12(2):471.

THE EFFECT OF DIFFERENT FABRIC CONSTRUCTIONS ON BUILDING REINFORCEMENT

Serdar Başev[1], **Güngör Durur**[2]
[1] *Spinteks Tekstil İnşaat Sanayi ve Ticaret A.Ş.Denizli / TURKEY*
[2] *Pamukkale University Textile Engineering Department Denizli/ TURKEY*
serdar@spinteks.com

INTRODUCTION

Technical textiles have developed significantly in recent years, and construction and building textiles (Buildtech) are included in the classification. [1]. FRPs (from carbon fibres) epoxy resin and carbon fibre reinforced plastics (CFRP) obtained with building reinforcement fibre polymer structures are seen as the fastest and most cost-effective reinforcement model [2]. In the study on concrete beam samples reinforced with fabrics made of carbon fiber, 5 different carbon reinforcement applications were made with different two-point tests. As a result of the application, the reinforcement type applied at 45° with the axis of the beam gave the highest beam shear strength. [3] Another study conducted a hybrid reinforcement study of carbon, glass and glass-carbon mix, 4 point testing on 5 beams, one of which was a witness, with different layers. It provided flexural strengths between 30% and 98%. Compared to the unreinforced beam, 30% increase in strength was achieved in glass fabric and 57% in carbon fabric. [4] 7 samples in 2 different concrete classes, 1 of the beams with CFRP reinforcement in the C20 and C30 class, with glass fiber fabric and U-shaped strips; the rest are L-shaped with CFRP reinforcement. [5] prepared beam samples with dimensions of 150x250x1500 mm and a compressive strength of 25 MPa, and made measurements with a 3-point test on 4 beams, 3 of which had different reinforcement forms. According to the results of their measurements, they stated that they reached the load capacity of 165% of the value of the witness sample in the reinforced beams. [6] 18 T-shaped beam samples were placed in 6 of the beams with different stirrups and reinforcement systems, and in the remaining 12 beams, different reinforcement systems were placed. According to the results, 4% to 90% increase in load carrying capacity in the bending direction for the 1st group and between 6 and 46% for the 2nd group has been achieved [7]

MATERIALS AND METHODS

In this study, fabrics produced from 12K (800 tex) carbon yarn, which is the most used in the field of reinforcement, were included in the experiment plan. For the experiments, bidirectional 12 K (800 tex) weft and warp direction carbon woven fabrics were woven in plain, twill and satin. In carbon fabrics, 400 gr/m^2 weight fabrics plain, twill and 3/1 broken twill, warp and weft yarn density 2,5 yarns / cm, 600 gr/m^2 weight fabrics plain, twill and 4/1 satin, warp and weft yarn density It is produced as 3,7 yarns/cm. According to TS-EN 12390-5, mold dimensions are adjusted as 100 mm width, 100 mm height, 400 mm length. In this case, the concrete beam sample was created as 100x100x400 mm. The L≥3.5 d requirement in the standard has been fulfilled.

Beam samples, which are kept in the mold for 24 hours, are kept in a conditioned pool, cured for 28 days in order to reach their ideal strength in water containing 1-1.5% lime at 20 °C and the concretes reached the ideal concrete strength. At the experimental stage, Spn Ep 225 brand epoxy was prepared by mixing 4:1. Of the two components, one component is reinforcement and the other is hardener.

RESULTS AND DISCUSSIONS

The test results of the beam samples and the effect of carbon woven fabrics in different patterns on the bending strength of fabrics with the same unit area weight were investigated. For 400 gr/m² carbon woven fabric, it is 7.36 MPa in plain weave, 8.21 MPa in 2x2 twill, 6.76 MPa in 3/1 broken twill, while the witness sample is 3.60 MPa. When viewed on a proportional basis, an increase of 106% is observed. The highest measurement value was obtained as a result of the reinforcement application made with 2/2 twill fabrics in double-sided 12 K 400 gr/m² fabrics.

For 600 gr/m² fabrics, the plain sample is 5.33 MPa, satin 7.45 MPa and 3/1 broken twill 5.47 MPa, while the witness sample is 3.98 MPa. When viewed on a proportional basis, an increase of 52% is observed. The highest measurement value was obtained as a result of the reinforcement application made with 4/1 satin fabrics in double-sided 12 K 600 gr/m² fabrics.

CONCLUSION

In reinforcement studies for beam bending strength with carbon fiber woven fabrics, the average flexural strength of all fabric types increased by 101%. The flexural strength increases according to fabric types were between 25% and 229%. Although this value changes in different types of concrete, the reinforcement made with woven carbon fabric will contribute to the strengthening works in countries experiencing intense earthquakes.

Keywords: Carbon Fabric, Woven Carbon Fabric, CFRP, Beam Strength, Building Reinforcement,

ACKNOWLEDGEMENT

The authors would like to thank to Spinteks Tekstil for the fabrics and support given.

REFERENCES

[1] DURUR, G. , VARAN, N. “İnşaat Tekstilleri ve Yeni Uygulamalar”, Tekstil Mühendis, 2007, vol. 68, pp 13-19,
[2] AKYILDIZ, A. , AĞIRGAN A.Ö., “Karbon Elyaf ile Sargılanmış Betonların Dayanımın İncelenmesi”, Electronic Journal of Vocational Colleges, 2016, vol. 6(3), pp 99-107.
[3] BUKHARI, I.A., VOLLUM, R.L., AHMAD, S., AND SAGASETA, J., “Shear strengthening of concrete beams with CFRP”, Magazine of Concrete Research, 2010, vol 62(1), pp 65-77
[4] HAWILEH, R.A., HAYDER, A., RASHEED, A., JAMAL, A.A., AND AL-TAMIMI, A.K., “Behavior of reinforced concrete beams strengthened with externally bonded hybrid reinforced polymer systems”, Material and Design, 2014, vol 53, pp 972-982.
[5] DONG, J., WANG., Q., AND GUAN, Z., “Structural behavior of RC beams with external flexural and flexural shear strengthening FRP sheets”, Composites Part B, 2013, vol 44, pp 604-612
[6] KÖKSAL, O.H., ALTINSOY, F., AKTAN., S., KARAHAN VE Ş. ÇANKAYA, R., “Üç Noktalı Eğilme Altında Betonarme Kirişlerde Karbon Lifli Polimerin Etkin ve Ekonomik Kullanımı”, Çanakkale Onsekiz Mart Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 2017, vol 3(2), pp 1-16
[7] AL-KHAFAJI, A. AND SALIM, A., “Flexural Strengthening of RC Continuous T-Beams Using CFRP”, Fibers, 2020, vol 8(41), pp 1-18

THE EFFECT OF YARNS MADE FROM DIFFERENT FIBER BLENDS ON QUALITY VALUES

Kübra Baykan[1], Esra Güneş[1]. Cansu Genç[1], Ersen Çatak[1], Çağla Deniz Şentürk[1]
[1] *SANKO Textile Research & Development Center / Gaziantep, TURKEY*
kubra.baykan@sanko.com.tr

ABSTRACT
In this study, yarn quality parameters of yarns produced using recycled cotton, virgin cotton and virgin viscose fibers produced in the open-end spinning system in the textile industry, which has an important place in the world, were investigated. As a result, it has been seen that the yarns produced with viscose fiber used have better quality values due to the loss of existing fiber properties in recycling processes.

Keywords: Sustanability, recyled cotton, virgin fiber, open-end

INTRODUCTION
Clothing, which is one of the basic needs of human beings, is met by the textile sector, which is an important sector covering the whole world. Textile products are among the sectors that show that the best solution is recycling, by becoming the sector where sustainable important steps should be taken at the point of recycling, by overconsumption due to the rapid growth of fashion and by overconsumption of textile products.

MATERIALS AND METHODS
In this study, as shown in Table 1, three different raw materials (R-CO, V-CO, V-CV) and two different mixing ratios (50:50 and 60:40), 20/1 and 30/1 open end The yarns produced in the spinning system were examined. [1] [2] IPI quality tests of the upcoiled yarns were carried out on USTER Tester 6 and USTER Tensojet devices. Quality parameters such as fineness, hairiness, strength, elongation were examined and the results were compared. [1]

Table 1. Trial Systematic

No	Yarn Ne	Composition	Explanation	Ratio
1	20/1	R-CO / CO	Recycled cotton + Cotton	%50-%50
2	30/1	R-CO / CO	Recycled cotton + Cotton	%50-%50
3	20/1	R-CO / CV	Recycled cotton + Viscose	%50-%50
4	30/1	R-CO / CV	Recycled cotton + Viscose	%50-%50
5	20/1	R-CO / CO	Recycled cotton + Cotton	%60-%40
6	30/1	R-CO / CO	Recycled cotton + Cotton	%60-%40

RESULTS AND DISCUSSION

Table 2. Yarn Quality IPI Values

No	Yarn Ne	Composition	Ratio	%U	%U CV	Hairiness	CN/tex	Elongation
1	20/1	R-CO / CO	%50-%50	10,65	13,43	4,74	14,94	5,4
2	30/1	R-CO / CO	%50-%50	12,52	15,82	4,09	13,47	4,74
3	20/1	R-CO / CV	%50-%50	9,59	12,12	4,46	12,5	6,7
4	30/1	R-CO / CV	%50-%50	11,56	14,6	3,92	11,7	5,36
5	20/1	R-CO / CO	%60-%40	11,04	13,93	4,9	14,31	5,52
6	30/1	R-CO / CO	%60-%40	12,71	16,04	4,28	13,49	4,46

When the quality parameters of the yarns produced were examined, it was observed that the fineness, strength and elongation values were bad in the thin yarns produced with 60:40, 50:50 ratios, using raw materials (R-CO, V-CO, V-CV). The reason for this is thought to have a negative effect on the quality values of the recycled cotton fiber used in the blends.

When the yarns in the Table 2. are examined, it is seen that the best result in terms of %U and %U CVm value is in yarn number 3 for 20/1 yarn and yarn number 4 for 30/1 yarn. It is thought that this is due to the viscose fiber used in the blend.

It has been observed that the hairiness value of the yarns is better in yarn number 3 for 20/1 and yarn number 4 for 30/1. As stated in the fineness quality parameter, the reason for this is that viscose fiber has a different structure from the pure cotton fiber used in other trials.

When the CN/tex and elongation values of the yarns are examined, it is seen that the yarn with the highest strength for 20/1 yarn is the number 1 yarn. When examined for 30/1 yarn, it was seen that yarn number 2 and number 6 with the same mixing ratio had high strength. It is thought that the reason for this is the virgin cotton used in the yarn content.

When the elongation value was examined, it was seen that for 20/1 and 30/1 yarns at 50:50 and 60:40 ratios, those made using virgin cotton had the lower elongation value. The virgin cotton used is thought to cause this.

CONCLUSIONS

In this study, the quality values of the yarns produced by using recycled cotton fiber with 50:50 and 60:40 ratios and virgin cotton and virgin viscose fibers with two different yarn counts in terms of sustainability in the textile sector were investigated. It is thought that this study will contribute to recycling research in the textile sector. The reason why recycled cotton fiber gives lower quality values compared to virgin cotton and virgin viscose fiber can be considered as the fiber losing its properties in recycling processes. Within the scope of this study, it is aimed

to examine the fabric performance parameters of the yarns whose quality values are examined by making knitted fabric in the future. [3] [4].

ACKNOWLEDGEMENT
Results presented here are part of the project (Project ID & Name: 22-BSP-002 & Studies on Recycled and Innovative Equivalent) conducted under R&D Center of Sanko Textile.

REFERENCES
[1] KAYNAK, K., & KILIC, G. B. (2019). Effects of waste cotton usage on properties of OE-rotor yarns. industia textila.
[2] TELLI, A., & BABAARSLAN, O. (2017). Usage of recycled cotton and polyester fibers for sustainable staple yarn technology. Tekstil ve Konfeksiyon.
[3] Vadicherla, T., & Saravanan, D. (2017). Effect of Blend Ratio on the Quality Characteristics of Recycled Polyester/Cotton Blended Ring Spun Yarn. Fibres & Textiles.
[4] Yüksekkaya, M. E., & Celep, G. (2016). A Comparative Study of Physical Properties of Yarns and Fabrics Produced from Virgin and Recycled Fibers. Journal of Engineered Fibers and Fabrics.

INFLUENCE OF COPET DISSOLUTION AND DYEING PROCESSES ON PHYSICAL PERFORMANCE OF BLACKOUTS FROM PET/COPET BICOMPONENT YARNS

Merve Bulut[1], Merve Küçükali Öztürk[2], Cevza Candan[1], Banu Nergis[1], Aysun Yenice[3], Egemen Kutlu[3], Rasim Boyacıoğlu[4], Ecenur Tor[4]

[1]Istanbul Technical University, Department of Textile Engineering, Istanbul, Türkiye
[2]Istanbul Bilgi University, Department of Textile and Fashion Design, Istanbul, Türkiye
[3]Kucukcalik Tekstil San. ve Tic. A.S., Bursa, Türkiye
[4]KFS Kucukcalik Filament ve İplik San. ve Tic. A.S., Sakarya, Türkiye
merve.bulut@itu.edu.tr

The quality of a building's indoor environment in relation to the health and well-being of those who occupy space within it is referred to as indoor environmental quality (IEQ) [1,2]. The most common application of textiles that impact the IEQ are textiles for the control of acoustics. Wall coverings, ceilings, curtains, chairs, carpets, etc. are designed to absorb sound and prevent echoes inside a room. The application of curtains as sound absorbers for room acoustical purposes has considerable advantages like being relatively cost-effective, lightweight, flexible, and easy to handle. Acoustic performance of home textiles, such as curtains, carpets, sofa covers, etc., can be improved by accurate selection of suitable textile materials, appropriate physical and processing parameters, layering and placement of acoustical textiles [3]. Sound absorbing properties of textile curtains are under ongoing interest of researchers [4-6]. Bicomponent and hollow fibers not only have a lower density than their solid profile fibers, have better thermal insulation but also favor acoustic properties. Textile materials from hollow fibers also have been widely used in sound absorption and noise reduction applications [7,8].

In this study, effect of CoPET dissolution and dyeing processes on physical properties of acoustic blackouts from C-shape PET/CoPET bicomponent yarns was investigated. Sound absorption performance of the samples were also presented.

For doing so, a woven blackout from textured PET warp and C-shape bicomponent PET/CoPET weft yarns with a weft-faced satin construction have been produced. The fabrics were tested for their physical and sound absorption properties in the loom state, after dissolving CoPET component to form the C-shape yarn in the weft direction and at the final state after dying. Some constructional properties of the samples are presented in Table 1.

Table 1. Some constructional properties of the samples

	Loom	Dissolved	Dyed
Thickness (mm)	0,45	0,68	0,54
Weight (g/m^2)	213,04	255,67	223,68
Fabric density (g/m^3)	469,24	375,99	414,21

A representative image of the bicomponent yarn after the dissolving process is also given in Figure 1.

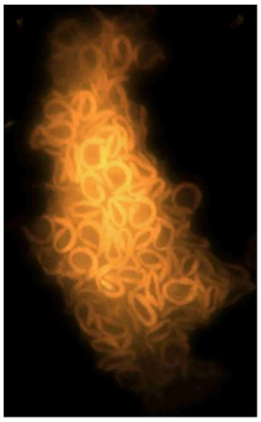


Figure 1. Cross-section of the dissolved PET/CoPET yarn

The results showed that alkali treatment applied to dissolve CoPET in the bicomponent yarns for obtaining C-shape fibers influenced constructional, mechanical and air permeability properties of the blackout curtains. The recorded properties were found to be satisfactory in terms of the expectations from commercial blackout curtains.
Finally, a comparative study of the sound absorption of the dissolved/dyed blackout with that of a commercial one was conducted.

Keywords: Blackout, bicomponent fiber, Pet, CoPet, dissolution

ACKNOWLEDGMENT
The authors acknowledge the funding by The Scientific and Technological Research Council of Turkey (TUBITAK) 1505 Program with the grant number 5210113.

[1] PRINIOTAKIS, Georgios; STACHEWICZ, Urszula; VAN HOOF, Joost. Smart textiles and the indoor environment of buildings. Indoor and Built Environment, 2022, 31.6: 1443-1446.
[2] PIEREN, Reto; HEUTSCHI, Kurt. Predicting sound absorption coefficients of lightweight multilayer curtains using the equivalent circuit method. Applied Acoustics, 2015, 92: 27-41.
[3] MEMON, Hafeezullah, et al. Considerations while designing acoustic home textiles: A review. Journal of Textile and Apparel, Technology and Management, 2015, 9.3.
[4] DEMIRYÜREK, Oğuz; AYDEMIR, Hüsnü. Sound absorbing properties of roller blind curtain fabrics. *Journal of Industrial Textiles*, 2017, 47.1: 3-19.
[5] PIEREN, Reto, et al. Sound absorption of textile curtains–theoretical models and validations by experiments and simulations. *Textile Research Journal*, 2018, 88.1: 36-48.
[6] BULUT, Hacer Merve, et al. A STUDY ON ACOUSTIC PERFOMANCE OF BLACKOUT CURTAINS.
[7] LIU, Xueting, et al. Sound absorption of hollow polyester woven fabric with honeycomb weave. *Applied Acoustics*, 2021, 180: 108148.
[8] VEIT, Dieter. Bicomponent Fibers. In: *Fibers: History, Production, Properties, Market*. Cham: Springer International Publishing, 2023. p. 569-583.

ARTIFICIAL INTELLIGENCE BASED ASSESSMENT AND OPTIMISATION OF KNITTED FABRICS SUITABLE FOR ALLERGIC INDIVIDUALS

Cevza Candan[1], Murphy M. Peksen[2] , Banu Nergis[1] , Bilge Koyuncu[3]
[1]Istanbul Technical University, Department of Textile Engineering, Istanbul, Türkiye
[2]Technische Universität München, School of Engineering and Design, München, Germany
[3]DeepTech Engineering Ltd., İzmir, Türkiye
candance@itu.edu.tr

Thermal comfort coupled with optimal breathability plays a significant role for allergic people. Allergic individuals can greatly benefit from wearing knitted garments due to their unique interconnected loops and structures providing versatile features. Their structures offer excellent insulation properties due to the air pockets formed within the loops. These air pockets trap warm air close to the body, creating a barrier against external cold temperatures and reducing heat loss. As a result, knitted garments help maintain a comfortable and warm environment for the wearer. In addition, the porous breathability of these fabrics allows for better air circulation, keeping the skin dry and minimizing discomfort. However, people with chronic skin diseases are especially prone to skin irritation or rashes and require additional attention where textiles have shown to be of great potential [1]. The stretch and recovery properties of knitted fabrics, including interlock, rib and single jersey structures, will ensure a snug fit without restricting movement, contributing to overall thermal comfort. The stitch combinations will affect flexibility and stretchability, providing different levels of comfort and freedom of motion that will directly determine the thermal and moisture management of the body. Apart from the structure, the material properties are of paramount importance. People prone to chronic issues are advised to reduce using synthetic materials that preferentially employ dispersing dye substances. Moreover, using allergy-inducing materials for different apparel layers requires attention [2,3].

In this ongoing research, the thermal and moisture management properties of various knitted fabric structures made from environmentally friendly fibres, including collagen peptide-enriched fibres like Umorfil viscose, Umorfil polyester (filament/staple), and Umorfil nylon, are being assessed. Traditional methods such as 3D Computational Fluid Dynamics (CFD) simulations [4,5] are employed to analyse flow and thermal behaviour, while experimental measurements provide input and validation data for comparison purposes. Analytical tools such as TOPSIS are utilised to facilitate decision-making processes. Additionally, an attempt is made to optimise the performance of alternative structures, such as purl-knitted fabrics, through the application of Artificial Intelligence-based analyses, which has received less attention thus far. The results reveal the huge potential of using the investigated materials and structures in layered combinations that have been precisely calculated and validated.

Keywords: Atopic Dermatitis, Collagen-peptide, Computational Fluid Dynamics, Artificial Intelligence, Knitted Fabric

ACKNOWLEDGMENT

The authors gratefully acknowledge Istanbul Technical University, Scientific Research Unit since the experimental data was obtained thanks to the project funded by ITU (MGA-2022-43650).

REFERENCES

[1] HUI, X., ZHU, H., SUN, G. (2016). Antimicrobial textiles for treating skin infections and atopic dermatitis. Gang Sun (Ed.), Antimicrobial Textiles. (s.287-303).8
[2] MOBOLAJI-LAWAL M., NEDOROST S. (2015). The Role of Textiles in Dermatitis: An Update. Curr Allergy Asthma Rep. 15: 17, 1-7. DOI 10.1007/s11882-015-0518-0.
[3] RICCI, G,. PATRIZI, A., BELLINI, F., MEDRI, M. (2006). Use of textiles in atopic dermatitis: care of atopic dermatitis. Curr Probl Dermatol. 33:127-43. doi 10.1159/000093940. PMID: 16766885.
[4] PEKSEN, M. ACAR, M., MALALASEKERA, W. (2018) Optimisation of machine components in thermal bonding process of nonwovens: Effect of the conveyer belt on the porous web performance. Journal of Industrial Textiles 47 (5) 978 – 990.
[5] PEKSEN, M. (2018). Multiphysics Modelling-Materials, Components, and Systems. London, England: Ed. Academic Press.

ECO-FRIENDLY DENIM THROUGH THE COLORS OF NATURE

Özgür Ceylan[1], **Irmak Taş**[1], **Neslihan Ak**[2], **Nurten Yılmaz**[2], **Ebru Tuğalan**[2]
[1] *Eskisehir Technical University*
[2] *Mavi Giyim Sanayi ve Ticaret A.Ş*
ozgurceylan@eskisehir.edu.tr

The world has been providing optimal conditions for humans with its diverse and abundant natural resources for millions of years. Yet, the increased production and waste generation after the industrial revolution have reached a level that threatens human life [1]. Sustainability is a multifaceted concept encompassing environmental, economic, and social dimensions. It can be defined as the preservation of quality, diversity, and productivity of life today without endangering the rights of future generations. The concept of sustainability needs to be addressed by all industries, including the textile industry. Textile industry is one of the most environmentally harmful industries in terms of resource consumption and the pollution from the production of raw materials to the final product, and even the disposal of waste after the end of the product's lifespan [2].

Denim, which first appeared in workwear with its high durability and strength properties, became one of the important figures in the fashion scene in the 1950s. Traditional denim fabric is produced through a twill weave with warp yarns dyed with indigo and weft yarns in their raw state, consisting of 100% cotton fibers [3]. Natural indigo is an organic dye obtained from the fresh leaves of the Indigofera tinctoria L. plant. Yet, since the invention of synthetic indigo in the late 1800s, the organic dye has been replaced due to increased demand [4]. The residues of the dyeing process in textiles consist of high amounts of waste dyes, auxiliaries, and various salts [5], resulting in a significant problem in terms of both pollution and toxicity to the environment.

Natural dyes were replaced by synthetic ones after the industrial revolution since they could not effectively meet the increasing demand and ensure the required color fastness. Yet, natural dyes gained increased attention as studies conducted in the 1980s revealed the negative effects of synthetic dyes on human health and the environment [6]. Traditional natural dyeing process has certain limitations that need to be addressed on an industrial scale. The clay dyeing method offers solutions to the main limitations of traditional natural dyeing, such as limited resources, small-scale production capacity, stability, color consistency and intensity, as well as the necessity of using metal mordants, which are harmful to human health [6].

Clay, as a mineral component which can be obtained from local sources/soils, is a dyeing material that stands out with its unique colors as well as positive properties such as UV protection, antibacterial properties, and skin-friendly characteristics. The use of biomordants and organic enzymes instead of metal mordants convey a positive impact in terms of toxicity issues in the textile industry.

Mavi began its journey as a denim brand locally in Istanbul in the early 1990s and has evolved into a global lifestyle brand today. With its All Blue Strategy, the brand showcases its

sustainability approach and aims to create an entire denim collection consisting of sustainable All Blue products by 2030. Mavi has undertaken projects that evaluate the sustainability of denim from various perspectives [7]. Within the scope of this study, Mavi's Natural Dye Collection, colored with clay, will be evaluated using a case study method.

The Natural Dye Collection demonstrates positive outcomes in terms of environmental sustainability priorities such as energy and water conservation (70% water savings), reducing carbon footprint (approximately 40%), and preserving clean water sources through sustainable processes. A comparison of clay dyeing with traditional natural and conventional dyeing methods is presented in Table 1.

Table 1. Comparison of Clay Dyeing Method with Traditional Natural and Conventional Dyeing Methods

PROPERTIES	CLAY DYE	CONVENTIONAL DYE	TRADITIONAL NATURAL DYE
Wide Range of Colors	✓	✓	✗
Color Fatness	✓	✓	✗
Durability	✓	✓	✗
Naturality	✓	✗	✓
Water & Energy Effiency	✓	✗	✓
Clean Waste Water	✓	✗	✓

Along with additional benefits such as UV protection, antibacterial properties, and skin-friendly characteristics, it is believed that clay dyeing will contribute to the widespread adoption of natural dyeing methods by offering unique products with various color options [7].

Keywords: Sustainable denim, Natural dye, Clay dye, Bio-mordant, Sustainable textiles

[1] ODABAŞI, S. Sürdürülebilir moda Tasarımı- Kavramlar ve uygulamalar. Ankara: Nobel Akademik Publishing, 2022.
[2] KALAYCI, E., AVİNÇ, O. O., BOZKURT, A. and YAVAŞ, A. Sustainable textile fibers obtained from agricultural wastes: Pineapple leaf fibers. Sakarya University Journal of Science, 2016, vol. 20, no. 2, pp 203-221.
[3] TOKSÖZ, M. ve MEZARCIÖZ, S. Denim kumaşlara uygulanan özel yıkama uygulamaları. Çukurova University Journal of the Faculty of Engineering and Architecture, 2016, vol. 28, no. 2, pp 141-148.
[4] BENLİ, H. İndigo boya tozunun denim fabrikası çalışan sağlığı üzerine etkisi. Karaelmas Journal of Occupational Health and Safety, 2022, vol. 6, no. 2, pp 97-105.
[5] WAMBUGUH, D. and CHIANELLIA, R. R. Indigo dye waste recovery from blue denim textile effluent: a by-product synergy approach. New Journal of Chemistry, 2008, vol. 32, no. 12, pp 2189-2194.
[6] http://www.maritasdenim.com/terra.html Date of access [26.11.2022]
[7] https://www.mavi.com/sustainability/highlights.html Date of access [26.05.2023]

NEW APPROACH FOR DYE EXTRACTION FROM *RUBIA TINCTORUM* AND *RESEDA LUTEOLA* PLANTS

Oumaima Chajii[1,3], Younes Chemchame[1,2], Reda Achahboune[3], Mohamed Dalal[3], Abdeslam El Bouari[1]

[1] *Physical Chemistry laboratory, Materials and Catalyse (LCPMC), Faculty of Sciences Ben M'sik - University of Hassan II – Casablanca, Morocco.*

[2] *Department of Traditional Weaving, Academy of Traditional Arts, Foundation of Hassan II Mosque, Casablanca, Morocco.*

[3] *Technical Center of Textile and Clothing (CTTH), Casablanca, Morocco.*

oumchajii@gmail.com

The textile industry is currently placing great importance on the development of environmentally friendly dyeing processes that ensure deep coloration and good fastness properties. In this context, the use of natural dyes in modern dyeing techniques represents a promising approach to green chemistry that should be adopted on a large scale. Various natural dyes are used to color materials such as wool, cotton, silk, fur, and leather. Natural dyes, obtained from plants and animals, are considered safe as they are neither toxic nor carcinogenic, and are also biodegradable. Unlike synthetic dyes, they do not contribute to water pollution and provide a more environmentally friendly alternative [1].

Three current extraction methods were performed on two plant species: *Rubia tinctorum L.* (common madder) and *Reseda luteola L.* (weld). Ultrasound-assisted extraction (UAE) and microwave-assisted extraction (MAE) were studied and compared to conventional heating reflux extraction (HRE) [2]. The effect of different operating conditions, such as time and solvent composition, and their relationship with the MAE and UAE techniques were investigated. The optimal extraction condition from *Rubia tinctoria L.* plant using MAE was achieved at 900 W for 4 minutes of treatment at 60 °C, with mixture solvent ethanol/water (20/80, v/v), whereas using the ultrasonic-assisted extraction (UAE), the optimal condition was reached for 40 minutes with ethanol/water (60/40, v/v). Both techniques have achieved the yield of 13% and 11.91%, respectively. For *Reseda*, the optimal condition using UAE technique was attained with 100% water as solvent and 35 minutes of treatment to obtain higher yield of 24.18%. The MAE method using ethanol/water (60/40, v/v) for 3 minutes, was found to be the second most effective method with a yield of 22.66%.

Table 1. Comparison of extraction methods Rubia tinctorum

Extraction conditions	**Reflux**	**UAE**	**MAE**
Temperatures (°C)	90°C	RT	60°C
EtOH /H_2O	0/100	60/40	20/80
Time (min)	60	40	4
Yield (%)	10,12	11,91	13

Table 2. Comparison of extraction methods Reseda luteola

Extraction conditions	Reflux	UAE	MAE
Temperatures (°C)	90°C	RT	60°C
EtOH /H_2O	0/100	0/100	20/80
Time (min)	60	35	3
Yield (%)	13,51	24,18	22,66

The extracted dyes were characterized by ultra-performance liquid chromatography photodiode array detection (UPLC-PDA) and Fourier-transform infrared spectroscopy (FTIR) [3].
The dyeing process based on the precedent techniques and anti-UV treatment are in progress for this work in order to achieve intense coloration and high fastness properties on the wool and cotton fibres, in compliance with the standard test ISO 105-C6A01, ISO 105 X12, and ISO 102-B02, as well as the UV protection factor (UPF>50), according to the AATCC-183: 2004 test [4].

Keywords: Natural dye, *Rubia tinctorum*, extraction, *Reseda luteola*, UV protection.

[1] M. SHAHID, SHAHID-UL-ISLAM, ET F. MOHAMMAD, « Recent advancements in natural dye applications: a review », J. Clean. Prod., vol. 53, p. 310-331, août 2013, doi: 10.1016/j.jclepro.2013.03.031.
[2] J. DUVAL, V. PECHER, M. POUJOL, ET E. LESELLIER, « Research advances for the extraction, analysis and uses of anthraquinones: A review », Ind. Crops Prod., vol. 94, p. 812-833, déc. 2016, doi: 10.1016/j.indcrop.2016.09.056.
[3] J. CHE ET X. YANG, « A recent (2009–2021) perspective on sustainable color and textile coloration using natural plant resources », Heliyon, vol. 8, no 10, p. e10979, oct. 2022, doi: 10.1016/j.heliyon.2022.e10979.
[4] S. BALIARSINGH, A. K. PANDA, J. JENA, T. DAS, ET N. B. DAS, « Exploring sustainable technique on natural dye extraction from native plants for textile: identification of colourants, colourimetric analysis of dyed yarns and their antimicrobial evaluation », J. Clean. Prod., vol. 37, p. 257-264, déc. 2012, doi: 10.1016/j.jclepro.2012.07.022.

EXPLORING EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) IN FASHION DESIGN STUDIES IN GERMANY AND IRAN – A COMPARISON

Hanieh Choopani[1], Anne Marie Grundmeier[2], Martina Glomb[3]
[1]*University of Education Freiburg and University of Applied Sciences and Arts Hannover, Kunzenweg 21, 79117 Freiburg, Germany*
[2]*Department Fashion and Textiles, University of Education Freiburg, Kunzenweg 21, 79117 Freiburg, Germany*
[3] *Department of Design and Media, Faculty III, University of Applied Sciences and Arts Hannover, Room 2A.2.04, Expo Plaza 2, 30539 Hannover, Germany*
hanieh.choopani@ph-freiburg.de

ABSTRACT

Following the Brundtland report, the United Nations declared Education for Sustainable Development (ESD) as the education strategy to empower students of all ages to become more conscious and responsible in terms of the environment and society, which also aims to drive people towards a green community and to be motivated to live sustainably [1][2][3]. ESD can be defined as a process of providing students with the knowledge and skills required to overcome a variety of environmental, social, and economic challenges [4][5][3]. Accelerating ESD is crucial to achieving the Sustainable Development Goals (SDGs).

The fashion system has a high environmental and social impact [6][7]. In this regard, considering the various approaches to the sustainable transformation of the fashion system, product design is particularly decisive. It is, therefore, necessary to start at this point in education to bring about changes in the system in the long term: "To educate in a way that sustains sustainability, new educational paradigms need to be introduced" [8]. So far, the sustainability concept, despite its great importance, has played a minor role in fashion design education and practical measurements in Iran. Additionally, it has not been considered as an influential factor in the discourse of sustainability in the country's industries specifically in the fashion industry [9]. The natural and cultural-scientific perspectives of sustainable development play a critical role in progressing the notion of ESD and are considered as an integrative approach to sustainability [10]. Universities are important (educational) institutions where ecological, social, and economic dimensions of society are considered in an integrated way. The aim is to develop solutions for current and future challenges and to train decision-makers for various fields of action [11]. Therefore, the curricular implementation of ESD in all study programmes is demanded for German universities [12].

Thus, this paper aims to explore the implementation of ESD in higher education studies of the fashion design field in these two different country-contexts, and the following research questions shall be answered:

1) Which sustainability aspects are already implemented in the academic curricula for fashion design studies in higher education in Germany and Iran?

2) To what extent and how is ESD applied in the academic curricula for fashion design studies in higher education in Germany and Iran?

First, a systematic literature review was conducted to explore to what extent the implementation of ESD for fashion design studies in higher education in Germany and Iran has been researched in recent years. Then, expert interviews with professors from the selected universities in Iran

and Germany were conducted to explore which sustainability aspects are already implemented and to what extent ESD is applied in the academic curricula for fashion design studies in higher education in the two countries. In the next step, the curricula of all selected universities were interpreted and also a keyword search on their websites was conducted. The selected universities include two universities in Iran, Art University and Alzahra University, and – so far – three universities of applied sciences and arts and one private university in Germany: Hannover University of Applied Sciences and Arts, Reutlingen University, HTW Berlin University of Applied Sciences and BSP Business & Law School. The two universities in Tehran are leading in the field of fashion design studies in Iran. The universities in Germany have been selected because they implement sustainable strategies in their fashion design curricula.

The results of the paper contribute to an understanding of ESD as a didactic approach and its implementation in fashion design studies.

Keywords: ESD, sustainability, fashion, textiles, higher education**,** Iran

REFERENCES

[1] PAUW, J.B., GERICKE, N., OLSSON, D., & BERGLUND, T. (2015), The effectiveness of education for sustainable development, *Journal of Sustainability, 7*(11), 15693-15717, https://doi.org/10.3390/su71115693
[2] UNESCO (2017), Education for sustainable development. Empowerment through knowledge, skills, and values to protect the planet, https://www.unesco.org/en/education/sustainable-development
[3] ABU BEDOR, S., KAMIS, A., SHAFIE, SH., AHMAD PUAD, F.N., JAMALUDDIN, R., & RAHIM, M.B., (2021), Issues and trends in fashion education sustainability, *Asian Journal of Vocational and Humanities, 2*(1), 9-18, https://doi.org/10.53797/ajvah.v2i1.2.2021
[4] SCHOPP, K., BORNEMANN, M., & POTTHAST, T. (2020), The whole-institution approach at the University of Tübingen: sustainable development set in practice, *Journal of Sustainability, 12*(3), 861, https://doi.org/10.3390/su12030861
[5] BELL, D. V. (2016), Twenty-first-century education: Transformative education for sustainability and responsible citizenship, *Journal of Teacher Education for Sustainability, 18*(1), 48-56, https://doi.org/10.1515/jtes-2016-0004
[6] MCKINSEY & GLOBAL FASHION AGENDA (GFA) (Eds.) (2020), Fashion on Climate. How the Fashion Industry Can Urgently Act to Reduce its Greenhouse Gas Emissions, https://www.mckinsey.com/~/media/mckinsey/industries/retail/our%20insights/fashion%20on%20climate/fashion-on-climate-full-report.pdf
[7] NIINIMÄKI, K. (2018), Sustainable fashion in a circular economy, In Niinimäki, K. (Ed.), *Sustainable fashion in a circular economy* (pp. 12-41), Aalto University: Finland.
[8] FLETCHER, K., & WILLIAMS, D. (2013), Fashion education in sustainability in practice. *Research Journal of Textile and Apparel, 17*(2), 81-88, https://doi.org/10.1108/RJTA-17-02-2013-B011
[9] DAVARI, R. (2017), Stating a sustainable development model for garments (Case Study: Iran) [Doctoral dissertation, Alzahra University, Tehran: Iran], The library of Alzahra University.

[10] GRUNDMEIER, A.M. (2017), Why education can foster sustainability in the fashion market, The 17th World Textile Conference AUTEX- Textiles- Shaping the Future. IOP Conf. Series: Materials Science and Engineering.
[11] BELLINA, L., TEGELER, M. K., MÜLLER-CHRIST, G., & POTTHAST, T. (2020)., Bildung für nachhaltige Entwicklung (BNE) in der Hochschullehre. BMBF-Projekt „Nachhaltigkeit an Hochschulen: entwickeln – vernetzen – berichten (HOCHN)“ [Education for sustainable development (ESD) in higher education teaching. BMBF project "Sustainability at universities: develop - network - report (HOCHN)"], https://www.hochn.uni-hamburg.de/-downloads/handlungsfelder/lehre/hochn-leitfaden-lehre-2020-neu.pdf
[12] MOLITOR, H., KRAH, J., REIMAN, J., BELLINA, L., & BRUNS, A. (2023), *Zukunftsfähige Curricula gestalten - eine Handreichung zur curricularen Verankerung von Hochschulbildung für nachhaltige Entwicklung* [Designing sustainable curricula - a handout on the curricular anchoring of higher education for sustainable development], Hochschule für nachhaltige Entwicklung Eberswalde, https://doi.org/10.57741/opus4-388

THE EFFECTS OF STORE WINDOW DESIGN ON CLOTHING BUYING BEHAVIOR

Buse Coşkun[1], Seher Kanat[2]
[1] *Ege University / Graduate School of Natural and Applied Sciences*
[2] *Ege University / Department of Textile Engineering*
seher.kanat@ege.edu.tr

INTRODUCTION

Store atmosphere is one the significant factors, which affect the buying decisions and therefore buying behaviors. Store atmosphere, which consists of the factors like used colors, odors, music, shelves and store window, affects the consumers' perceptions and their buying decisions. At this point, store window, which is one of the prominent store atmosphere factors, is the first point where consumers and brands interact with each other. A store window, which is attractively designed and possesses a high visual quality, attracts the consumers to the store and causes them to shop from this store. Therefore, store window design becomes a significant factor for brands and retailers that operate in clothing sector in which visual design is very important. In this context, this research aims to analyze the effects of store window design on clothing buying behavior.

There are studies in the literature, which analyze the effects of store window design on buying behavior and preferences of consumers on the basis of clothing sector. These studies [1 – 5] focus on a specific brand or brand identity, a specific behavior, the importance of store window design in clothing sector and how it should be. However, this research focuses on the effects of store window design on clothing buying behavior generally without taken into consideration a specific brand or a behavior. Thus, this research alters from other studies within the literature.

METHOD OF THE RESEARCH

In accordance with this aim, a survey is conducted to consumers whose ages are 18 and over and who live in three biggest cities of Türkiye (İstanbul, Ankara and İzmir). Consumers whose ages are 18 and over are incorporated in the research because the age of legal majority is 18 in Türkiye. Besides, İstanbul, Ankara and İzmir provinces are selected because they can represent the country-wide due to their cosmopolite structures and population densities.

According to data of Turkish Statistical Institute [6], Türkiye's population is 84.680.273 by 31.12.2021. The number of individuals, whose ages are 18 and over, is 61.941.973. Sample size is calculated as 384 at 95% confidence interval with 5% error margin. The individuals, who constitute the sample, are determined according to simple random sampling.

The surveys are carried out between February 2023 and May 2023. Online survey technique is used. Survey form consists of 9 main and 32 sub-questions. Ege University's Ethical Board of Social and Human Sciences Scientific Research and Publication has ethically approved the survey in 26.10.2022 with 1643 protocol number. 433 survey forms are incorporated in the research. The obtained findings are analyzed by using SPSS program.

ANALYSIS OF THE RESEARCH FINDINGS

The questionnaire's reliability is calculated and the reliability co-efficient α is found as 0,962. According to this, the scale of the questionnaire is found to be highly reliable. Besides, the participants are found that they are generally well-educated young consumers who possess low or low- middle incomes. 79% of the participants separate 20% or less from their monthly budgets for clothing expense. In addition to these, the clothing brands, which are mostly bought by participants, can be respectively listed as; LC Waikiki, Zara, Mavi, Koton and DeFacto. However, the participants indicate that they mostly like the store window designs of Zara, Mavi, Koton, DeFacto, Beymen and LC Waikiki, respectively.

According to the obtained research results, consumers mostly affected from the store window designs in which the prices of products are given. Besides, they indicate that store window design is effective on their entrance to clothing stores and on their clothing product selections. In addition to these, the bright store window design is another important factor that affects the clothing buying behavior of consumers. Also, the consumers absolutely enter the clothing stores, which they like their store window designs. They can follow fashion and trends via store window designs and they are affected from the colors that are used in store window designs. Finally, they are more affected from store window designs, which possess a theme or tell a story.

According to the results of carried exploratory factor analysis, the cumulative variance of three new factors (store window properties of clothing stores, the effects of store window design on clothing store entrances and clothing product buying, the effects of store window design on clothing shopping habits) is found as 67,5%. Performed hypotheses tests indicate that the store window properties of clothing stores do not alter on the basis of gender, age, education level and income level. However, the effects of store window design on clothing store entrances and clothing product buying are much higher on women consumers and on consumers, who possess an education level of university or more. Besides, the effects of store window design on clothing shopping habits are much higher on men consumers, on consumers, who are aged 42 or more and on consumers, who possess 1600 dollar monthly income or less.

RESULTS AND GENERAL EVALUATION

According to the obtained results within the scope of research; consumers are more affected from store window designs, which has bright design, in which price information are given and which possess a theme or tell a story. Besides, they are affected from color use within the store window design and they indicate that store window design is effective on their entrance to clothing stores and on their clothing product selections. In this context, the clothing brands and retailers should give the necessary significance to their store window designs. They should design bright and attractive store windows which include price tags and coherent colors and possess a theme or tell a story.

Keywords: Store window design, store atmosphere, clothing sector, buying behavior, consumer

REFERENCES

[1] ZHOU, L. Research on the window display design on the modern brand clothing. Proceedings of the 2015 International Conference on Economics, Social Science, Arts, Education and Management Engineering, 2015, vol.38, pp:441-446.
[2] CHENG, S.Y. and LIANG, J.F. Analysis on the influence of clothing window display to consumer behavior. Textile Bioengineering and Informatics Symposium Proceedings, 2014, vol.1-2, pp:495-502.
[3] OH, H. and PETRIE, J. How do storefront window displays influence entering decisions of clothing stores?. Journal of Retailing and Consumer Services, 2012, vol.19, pp:27-35.
[4] SUN, M.Q. and MA, D.L. Signifying interpretation of clothing window display design. Proceedings of the 2010 International Conference on Information Technology and Scientific Management, 2010, vol.1-2, pp:196-198.
[5] SOMOON, K. and SAHACHAISAEREE, N. Factors determining window display conveying merchandise's positioning and style: a case of shopping mall clothing display targeting undergraduate students. Procedia Social and Behavioral Sciences, 2010, vol.5, pp:1236-1240.
[6] Turkish Statistical Institute. Address Based Population Registration Statistics 2021. Population by Province, Single Age and Gender. Available on https://data.tuik.gov.tr/Kategori/GetKategori?p=Nufus-ve-Demografi-109 (Date of access: September 2022)

SUSTAINABLE FASHION: A HISTORICAL REVIEW

Edit CSANÁK
Óbuda University, Rejtő Sándor Faculty of Light Industry and Environmental Engineering, Product Design Institute, Hungary, Budapest, 1034 Doberdó út 6.
csanak.edit@rkk.uni-obuda.hu

The history of sustainable fashion traces the evolution of an industry that has undergone significant transformations in response to growing environmental and social concerns. This abstract provides an overview of the key milestones and developments in sustainable fashion, highlighting the motivations, challenges, and achievements that have shaped its trajectory. [1] [2]

Sustainable fashion emerged as a response to the fast fashion industry's detrimental environmental and social impacts. The production and consumption patterns of fast fashion, characterised by rapid turnover, cheap labour, and resource-intensive processes, contributed to environmental degradation, exploitation of workers, and waste accumulation. Consequently, a global movement arose, advocating for a more sustainable and ethical approach to fashion. [2]

The early 1990s witnessed the first significant efforts towards sustainable fashion, introducing organic and eco-friendly materials, such as organic cotton and recycled fabrics. Simultaneously, pioneering designers and brands began exploring alternative production methods, emphasising transparency, fair trade, and ethical sourcing.

As the 21st century progressed, sustainable fashion gained momentum through various initiatives. Establishing certification systems and standards, such as Global Organic Textile Standard (GOTS) and Fairtrade, helped consumers identify and support sustainable products. Collaborations between fashion brands, NGOs, and governmental bodies further bolstered sustainable practices, promoting responsible sourcing, reducing carbon footprint, and supporting worker welfare. Technological advancements have been pivotal in fostering sustainability within the fashion industry in recent years. Innovations like 3D printing, upcycling, and digital design tools have opened new avenues for creative expression while minimising waste and reducing reliance on virgin resources. Furthermore, the rise of e-commerce and digital platforms has facilitated the growth of sustainable fashion, making it more accessible to a broader audience. [3]

The history of sustainable fashion has its challenges. Scaling up sustainable practices, overcoming supply chain complexities, and changing consumer mindsets remain ongoing obstacles. However, the increasing awareness and demand for sustainable alternatives have prompted many fashion companies to integrate sustainability into their core strategies.

Looking ahead, the history of sustainable fashion serves as a testament to the power of collective action and innovation in addressing the environmental and social impacts of the fashion industry. As stakeholders continue to collaborate, innovate, and educate, sustainable fashion has the potential to transform the entire industry, promoting a future where style and ethics go hand in hand.[4-16]

The article attempts to present and explore the history of environmental trends in fashion, exploring the key findings of the literature published on the topic and extending it with the information of individual research.

Keywords: sustainable fashion, fashion industry, textile industry, eco-fashion

REFERENCES

[1] S. BLACK, Eco-chic: The Fashion Paradox, London: Black Dog Press, 2008.
[2] S. BLACK, The Sustainable Fashion Handbook, New York: Thames & Hudson, 2013.
[3] E. L. CLINE, Overdressed: The Shockingly High Cost of Cheap Fashion, New York: Portfolio, 2013.
[4] S. MINNEY, Slow Fashion: Aesthetics Meets Ethics, New Internationalist, 2016.
[5] E. CSANÁK, „ECO-FRIENDLY CONCEPTS AND ETHICAL MOVEMENTS IN THE FASHION INDUSTRY," in University of Zagreb, Zagreb, 2014.
[6] R. LA FERLA, „FASHION: European Report -- London/Milan; Marketing the Millennium," The New York Times Magazine, p. 66., 14. January 1990.
[7] W. HOCHSWENDER, „The Green Movement in the Fashion World," The New York Times, p. 1., 25. March 1990.
[8] L. BORRELLI-PERSSON, „You Had to Be There: Remembering Imitation of Christ's Shock-Goth Funeral Parlor Show of Spring 2001," 24. October 2019. [Online]. Available: https://www.vogue.com/article/reflections-on-imitation-of-christ-spring-2001-ready-to-wear-funeral-parlor-show. [Accessed: 30. March 2023.].
[9] Fibre2Fashion, „The Ethical Fashion Show," October 2008. [Online]. Available: https://www.fibre2fashion.com/industry-article/3694/the-ethical-fashion-show. [Accessed: 30. March 2023.].
[10] S. MENKES, „Eco-friendly: Why Green Is the New Black," International Herald Tribune, 6. Május 2006.
[11] R. SULLIVAN, "Sustainable Style—Eco-ethical Chic: Earth to Fashion," Vogue, May 2007.
[12] Earth Pledge Foundation, Future Fashion White Papers, New York: Earth Pledge Foundation, 2008.
[13] T. S THORISDOTTIR and L. JOHANNSDOTTIR, "Corporate Social Responsibility Influencing Sustainability within the Fashion Industry. A Systematic Review," MDPI Open Access Journals: Sustainability, vol. 12., no. 21: 9167., 2020.
[14] The Business of Fashion, Anti-Fashion: A Manifesto for the Next Decade | Li Edelkoort | #BoFVOICES, 2017.
[15] K. WOO, „Remembering One of Rei Kawakubo's Most Boundary-Breaking Shows," 4 May 2017. [Online]. Available: https://www.nytimes.com/2017/05/04/t-magazine/fashion/rei-kawakubo-not-making-clothes-oral-history.html.
[16] VOGUEPEDIA, „Voguepedia: The World of Fashion in Vogue," [Online]. Available: http://www.vogue.com/voguepedia/Eco_Fashion. [Accessed: 6. June 2023.].

ADVANCED DIGITAL TECHNOLOGIES IN FASHION DESIGN

Nurşah Çağlar[1], Melis Küçükyılmaz[2], Cevza Candan[3], Deniz Özdemir[4], Nilüfer Esmerdağ[5], Feride Hasret[6]
[1,2,3] Istanbul Technical University / Department of Textile Engineering / Istanbul, Türkiye
[4,5,6] ATT Textile / İstanbul, Türkiye
caglarnur@itu.edu.tr

The rapid development and transformation of the digital world emerge as a significant leap forward in all aspects of human life. The widespread use of technologies such as the Metaverse, virtual reality, and augmented reality indicates the beginning of a new era. The Metaverse refers to a three-dimensional virtual artificial environment where users act as alter egos and interact with each other, providing an alternative reality [1]. The fashion industry has also adapted to this rapid transformation of the digital world, giving rise to the concept of "virtual fashion," which engages with new techniques and different platforms. Decentraland, a three-dimensional virtual world-based platform, hosted the first Metaverse fashion week, where over sixty fashion brands conducted their fashion shows [2]. Anifa Mvuemba's live-streamed three-dimensional fashion show on the Instagram platform in 2020 is considered one of the pioneering initiatives in the digital space [3]. Based on these connections, all stakeholders and users in the industry have gained access to unlimited possibilities to showcase their creativity in the environment offered by the digital world.

RESEARCH PROBLEM / HYPOTHESIS

Many challenging events in history have led to the emergence of innovative ideas that have changed people's lives. These events have prompted individuals to develop new technologies for a more efficient, safer, and better life. Similarly, the Covid-19 pandemic has activated human beings' innovative thinking and accelerated the digital transformation in various sectors, including the fashion industry. The strategy of global fashion brands adopting sustainable fashion principles has led to the emergence of innovative ideas such as opening virtual stores and preparing three-dimensional fashion shows. During the pandemic period, where physical opportunities were limited, new needs emerged in the education of fashion and textile design within the limitations of remote education methods. In line with these needs and accessible opportunities, a professional digital fashion show composed of fashion design students' collections was developed using 3D virtual fashion as well as advanced graphical design programs in collaboration with the industry in order to increase young designers' awareness for the digital resources and tools, to explore the benefits as well as challanges of the digitilization in fashion education and industry.

METHODOLOGY

This study focuses on realizing an advanced digital fashion show composed of various collections within the framework of university-industry collaboration. The preparation and implementation of the collections have led to a process that effectively utilizes all the advanced digital tools provided by this collaboration. Digital design elements have been used in conjunction with the tools already used in the traditional ready-to-wear industry. Special design and presentation opportunities offered by this collaboration have also been utilized. Following the process of creating garment designs and concept boards, the corresponding computer-aided pattern models were developed using CLO3D, a three-dimensional digital fashion design software, and all other design steps were completed using this software. A sample design is

demonstrated in Figure 1. Designs were simulated and transformed into videos by creating three-dimensional content in Blender, a three-dimensional modeling and animation program.

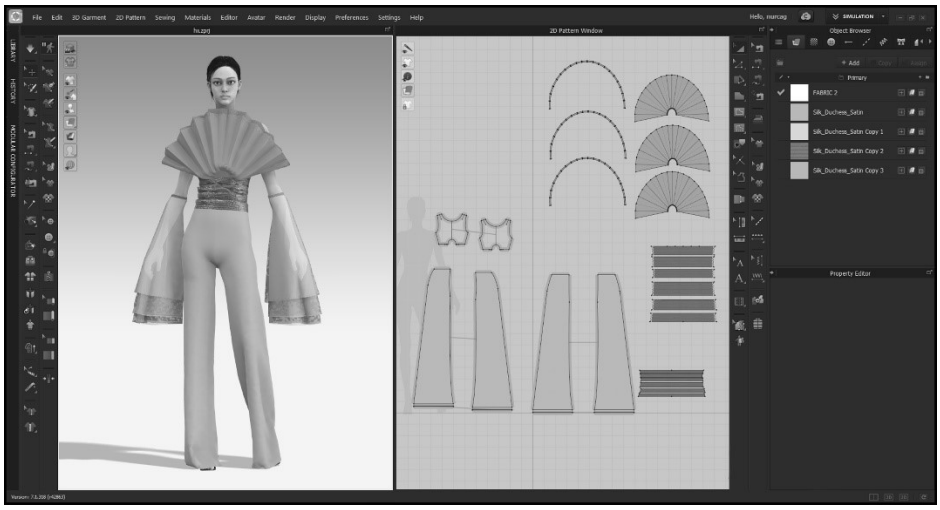


Figure 1. Pattern and model application in the CLO3D program

RESULTS AND CONCLUSIONS

The advanced digital fashion show, which is one of the very first examples of the university and industry collaboration, has provided all the stakeholders with the opportunity to engage in an original design process encouraging not only creativity, but also facilitating adaptation to the digital world regarding future scenarios as well as enhancing industrial and academic expertise in advanced digital fashion technologies.

Keywords: Digital fashion, Virtual fashion, Cad, 3D Fashion, CLO3D

ACKNOWLEDGMENT: The Authors would like to thank ATT Clothing company for their efforts for this study.

[1] LEE, Jee Young. A study on metaverse hype for sustainable growth. International journal of advanced smart convergence 10, no. 3 (2021), 72-80.
[2] Decentraland Metaverse Fashion Week 2022 Case Study. Retrieved May, 10, 2023 from, https://landvault.io/portfolio/decentraland-fashion-week
[3] SEGRAN, Elizabeth. Hanifa's virtual 3D fashion show is haunting, beautiful, and brilliantly executed. (2020, June, 9). Retrieved May, 10, 2023 fron https://www.fastcompany.com/90513959/hanifas-virtual-3d-fashion-show-is-haunting-beautiful-and-brilliantly-executed

AN INVESTIGATION ON THE EFFICIENCY OF AN IN-HOUSE FABRIC RECYCLING LINE UTILISATION FOR PRE-CONSUMER DENIM WASTES

Ebru Çalışkan[1], Cem Güneşoğlu[2], Ali Çifçi[3]
[1] Baykan Denim R&D Center, Malatya
[2] Gaziantep University Textile Engineering Department Gaziantep
[3]Orta Anadolu R&D Center, Kayseri

Ebru.Caliskan@baykandenim.com

ABSTRACT
This paper investigates the efficiency of an in-house fabric waste recycling line to recycle the pre-consumer denim fabric wastes. The results gave satisfying performances in ring spinning with recycled cotton fibers; so it was possible to contribute a sustainable process example in denim industry.

Keyword: Denim, recycling, Ring yarn

INTRODUCTION

Denim is a type of cotton woven fabric which is characterized by thick, indigo dyed warp yarns, ecru weft yarns, high sett, weight and abrasion resistance. The global denim market was valued at around 70 Billion USD in 2021 and expected to reach a value of around 107 Billion USD in 2023. This huge market resulted with sustainable process applications. Denim industry has various sustainable process approaches to reduce water consumption, environmental-friendly chemical and dye usage, to reduce the air pollution during production and recycling of wastes [1-3]. Since denim fabrics have quite higher weight, tensile and tearing strength compared to non-denim fabrics, conventional fabric waste recycle lines have difficulty to obtain good quality recycled cotton fibers at final. It is also known that yarn spinning wastes give better quality recyled fibers than that of fabric wastes. This study includes the utilisation of an in-house fabric waste recycling line which has higher number of pulling stations and different garneting wire cross-section than conventional. Pre-consumer denim apparel wastes are subjected to recycling by that in-house line for the very first time and recycled fibers are than characterized by means of the HVI along with virgin cotton fibers. Than, Ne 10 virgin : recycled cotton (from spinning and denim wastes separately) 80:20 blend ring yarns were produced; the standard quality control tests and tensile measurements were applied. The results showed that the proposed line would be successfully used to recyle the denim fabric wastes to produce ring yarns at even industrial scale.

REFERENCES
[1] BUSCIO, V. et al. Sustainable dyeing of denim using indigo dye recovered with polyvinylidene difluoride ultrafiltration membranes. Journal of Cleaner Production, 1979, vol. 91, pp 201-207.
[2] NAYAKI, R. et al. Laser and ozone applications for circularity journey in denim manufacturing - A developing country perspective. Current Opinion in Green and Sustainable Chemistry, 2022, vol. 38, pp 100680.

[3] MEZARCIÖZ, S. et al. Effect of Sustainable Cotton Fibers on Denim Fabric Selected Properties. Journal of Natural Fibers, 2021, vol. 19, no. 15, pp 10345-10355.

DESIGN AND DEVELOPMENT OF MULTIFUNCTIONAL FABRIC USING COATING METHOD WITH DIFFERENT FINISHING PROCESSES

Eylen Sema Dalbaşı[1], **Gonca Özçelik Kayseri**[2]
[1] *Ege University Department of Textile Engineering, Bornova, İzmir, Türkiye*
[2] *Ege University Emel Akın Vocational Training School, Bornova, İzmir, Türkiye*
sema.namligoz@ege.edu.tr

Nowadays, the design and production of multifunctional textiles and high added value products have started to gain importance with the changes in the textile industry. In this way, the market shares of multifunctional textiles with different and functional properties are increasing compared to conventional textiles. The most important properties required from the textile materials are water, oil and stain repellency.

The basis of the water repellency process is to create a water-repellent layer on the surface of the yarns with chemicals having a long-chain water-repellent group by reducing the surface tension of the fabric against water. Cotton fibers have a hydrophilic structure to a greater or lesser extent. Since the water repellency process creates a water-repellent layer only on the surface of the yarns, the internal structure and pore structure of the fabric are not adversely affected in any way and remain the same [1]. As the structure of the dirt and the way it affects and adheres to the textile surface are very different, it is very difficult to obtain effective results for all dirts with a single treatment on dirt repellency. However, mainly dry and wet staining forms can be mentioned. In dry staining, it can be in the form of filtering all kinds of dust and pollutant particles by textiles (curtain), collapsing on it (upholstery) or attracting pollutants by electrostatic charge (synthetics). In wet soiling, wet dirt or oily, watery dirt are poured directly on textile and contaminates it. By applying stain repellency treatments to the fabrics, the textile materials are protected from getting dirty quickly during usage [1].

The superhydrophobicity on the cotton fabric can be achieved by constituting nano or micro roughness structures on the surface of the fabric with low surface energy materials by using different micro and nano particles such as SiO_2, ZnO, TiO_2, Ag_2O, CuO, fluoroalkyl silane and, polymers [2,3]. Silicon dioxide (SiO_2) is an inorganic material widely used in various fields, including nanocomposites, because of its unique properties. It is also used as construction materials, ceramics, textile coating materials, drugs, adsorbents, ion exchangers and catalysts [4]. TiO_2 has characteristics such as sound insulation, good mechanical properties, thermal and chemical stability and TiO_2 compounds are used in various fields such as electronics, biomedical, optics, dermatological and photocatalytic. TiO_2 is applied to fabrics by coating technique, sol-gel process and chemical deposition method [5]. TiO_2 nano particles are used in processes such as self-cleaning, UV protection, flame retardancy, antibacterial activity, especially of cotton and wool fabrics. [6].

Lamination and coating are techniques applied to add functional properties to fabrics used in technical textile production and to increase their usage fields such as agricultural textiles, medical textiles and protective clothing. The functional properties of these fabrics may vary depending on the coating material used, the production technique applied, and the structure characteristic of the textile surface [7].

The aim of this study is to produce multifunctional 100% cotton woven fabrics by applying water, oil and stain repellency treatments. TiO_2, SiO_2 nano powders in different blended ratios, such as 100/0, 70/30, 50/50, 30/70, 0/100% were applied to 100% cotton woven fabrics by coating method. TiO_2 nano powder and SiO_2 nano powder were supplied from Nanografi Company (Turkey) [8]. Ethanol, HCl, polyacrylate synthetic thickener, binder, fixator, and fluorocarbon were also used in the coating applications. The various coating recipes were applied to the cotton fabrics in Mathis AG laboratory type coating machine and the fabrics were dried and cured in Ataç GK 40 laboratory type stenter.

Table 1 shows the recipes of the coating applications. Since the best results were obtained with the recipe having the ratio of TiO_2 /SiO_2 was 30/70, subsequent trials with this ratio was made by also adding fixator and fluorocarbon (Fabric 6,7,8), as given in Table 2. Three different recipes (Fabric 6,7,8) were applied to the fabrics with the constant ratio of TiO_2 /SiO_2 but in different ingredients as given in Table 2.

Table 1. The recipes of the coating applications treatments (Fabric 1-5)

Chemical type	**TiO_2/ SiO_2 ratio**					**Unit**
	100/0	70/30	50/50	30/70	0/100	
	Fabric 1	**Fabric 2**	**Fabric 3**	**Fabric 4**	**Fabric 5**	
Synthetic thickener	15	15	15	15	15	g/kg
Binder	150	150	150	150	150	g/kg
TiO_2	10	7	5	3	0	g/kg
SiO_2	0	3	5	7	10	g/kg
Ethanol	330	165	165	165	165	g/kg
HCl	-	165	165	165	165	g/kg
Water	X	X	X	X	X	g/kg
Total	1000 g	1000 g	1000 g	1000 g	1000 g	
Coating → Drying (80°C-10 min.) → Fixation (150°C-5 min.)						

Table 2. The recipes of the coating applications treatments (Fabric 6,7,8)

Chemical type	**TiO_2/ SiO_2 ratio**			**Unit**
	30/70	30/70	30/70	
	Fabric 6	**Fabric 7**	**Fabric 8**	
Synthetic thickener	15	15	15	g/kg
Binder	100	100	100	g/kg
TiO_2	6	9	12	g/kg
SiO_2	14	21	28	g/kg
Fixator	10	10	10	g/kg
Fluorocarbon	20	20	20	g/kg
Ethanol	330	330	330	g/kg
HCl	165	165	165	g/kg
Water	X	X	X	g/kg
Total	1000 g	1000 g	1000 g	
Coating → Drying (80°C-10 min.) → Fixation (150°C-5 min.)				

After the applications, according to standard test methods various physical and chemical tests such as water, oil, stain repellency, contact angle, circular bending rigidity, air permeability, surface roughness, and tear strength tests of the untreated and treated fabrics were carried out [9-15].

The obtained results were evaluated. As a result of the water repellency test, the best water repellency value was determined in Fabric 1 and 2. In terms of oil repellency, the best oil repellency value was found in Fabric 6, 7 and 8. In the stain repellency tests for tea and coffee stains, the best result was found in Fabric 8. In the stain repellency test for wine stains, the best results were found in Fabric 1, 2 and 3. The highest contact angle values in the contact angle measurement were determined in Fabric 1, 2 and 3. The lowest circular bending strength values were found in Fabric 2 and 3, while the highest circular bending strength values were found in fabrics 7 and 8. The air permeability values of all coated fabrics decreased compared to the values of untreated fabric. The coating applications caused decrease in the tear strength values of the fabrics. Fabric 8 has the highest tear strength value among the coated fabrics.

Keywords: Cotton, TiO_2, SiO_2 nano powder, water, oil and stain repellency, contact angle

REFERENCES

[1] ÇOBAN, S. Genel Tekstil Terbiyesi ve Bitim İşlemleri (In Turkish), ISBN NO: 975-483-457-1, 1st edition. İzmir: Ege University Textile and Apparel Research Center, 1999.
[2] CHAUHAN, P., KUMAR, A., & BHUSHAN, B. Self-cleaning, stain-resistant and anti-bacterial superhydrophobic cotton fabric prepared by simple immersion technique. Journal of colloid and interface science. 2019, Vol.535, pp.66-74.
[3] PANDA, A., VARSHNEY, P., MOHAPATRA, S. S., & KUMAR, A. Development of liquid repellent coating on cotton fabric by simple binary silanization with excellent self-cleaning and oil-water separation properties. Carbohydrate Polymers, 2018, Vol.181, pp.1052-1060.
[4] GASHTI, P. M., ALIMOHAMMADI, F., SHAMEI, A. Preparation of water-repellent cellulose fibers using a polycarboxylic acid/ hydrophobic silica nanocomposite coating, Surface & Coatings Technology 206, 3208-3215, 2012
[5] ZHAN, J., ZHANG, H., ZHU, G. Preparation of photocatalytic cenosphere immobilized with TiO_2 nanoparticles by hydrothermal method. Journal of Industrial Textiles, 2014, Vol. 44(1), pp.99-114.
[6] DHINESHBABU, NR., ARUNMETHA, S., MANIVASAKAN, P., KARUNAKARAN, G., RAJENDRAN, V. Enhanced functional properties of cotton fabrics using TiO_2/SiO_2 nanocomposites. Journal of Industrial Textiles, 2016, Vol.45(5), pp.674-692.
[7] BULUT, Y., SÜLAR, V. Kaplama veya laminasyon teknikleri ile üretilen kumaşların genel özellikleri ve performans testleri(In Turkish), Tekstil ve Mühendis, 2008, Year.15, No.70-71, pp.5-16.
[8] http://nanografi.com.tr, 2023.
[9] AATCC TM 22-2017 standard, Water Repellency: Spray Test, 2017.
[10] AATCC TM 118-2020 standard, Oil Repellency: Hydrocarbon Resistance Test, 2020.
[11] AATCC TM 130-2018 standard, Soil Release: Oily Stain Release Method, 2018.
[12] ASTM D 4032-08 standard, Test Method for Stiffness of Fabric by the Circular Bend Procedure, 2012.
[13] EN ISO 9237 standard, Textiles-Determination of permeability of fabrics to air, 1996.
[14] JIS B 0601standard, Surface Texture: Profile Method-Terms, Definitions and Surface Texture Parameters, 2013.
[15] EN ISO 13937-1 standard, Textiles- Tear properties of fabrics- Part 1: Determination of tear force using ballistic pendulum method (Elmendorf), 2001.

OPTIMIZATION OF THE PARAMETERS INFLUENCE BLEACHING PROCESS FOR NETTLE/COTTON MIXED FABRICS BY TAGUCHI METHOD

Yasemin Dülek[1], İpek Yildiran[1], Esra Mert[1], Buğçe Sevinç[1], Ümmet Kurtuluş[1], Burcu Yilmaz[2], Dilek Kut[3]

[1] SYK Textile R&D Center, Bursa, Turkey
[2] Marmara University, Faculty of Technology, Department of Textile Engineering, İstanbul, Turkey
[3] Bursa Uludag University, Faculty of Engineering, Department of Textile Engineering, Bursa, Turkey
yasemindulek@sykteks.com

The use of natural fibers in the clothing industry has a long history. Natural fibers used within the scope of sustainability and circular economy; wool, silk, cotton, linen, jute, ramie, nettle, kapok etc. can be listed as. Nettle, one of the cellulosic fiber groups, has been used in many fields (medical, food, cosmetics, medicine and textile etc.) throughout history [1]. Despite this, there are few studies in the literature on nettle yarn and fabrics obtained from the nettle plant [2], [3], [4]. Fabrics produced from nettle yarn provide well insulation due to the hollow structure of the characteristic cross-section of the fiber, while at the same time showing breathability. Thanks to 17% high quality fibers, the nettle plant has a better strength value than other natural fiber types such as cotton and linen. Nettle fiber, which is also a stalk fiber, is foreseen as an alternative to flax and cotton. Today, the negative effects of excessive water consumption and pesticides used in cotton production have increased the demand for nettle fibers. On the other hand, the nettle plant, which is widely grown in the Black Sea Region in our country, also creates a potential for domestic nettle yarn production [5].

In the study, it is aimed to reveal the advantages of nettle-based woven fabrics, which are more environmentally friendly and have superior comfort properties, as an alternative to cotton and linen-containing woven fabrics, which are mainly used in women's upper clothing products. Within the scope of the study, the whiteness index, tear strength, color yield and hydrophilicity properties of cotton, cotton/linen and cotton/nettle blended woven fabrics were analyzed comparatively.

All fabrics used in the study (cotton, cotton/linen and cotton/nettle) were desized before bleaching. In order to determine the bleaching process conditions that provide the best performance properties, the experimental set was created by using the Taguchi Method instead of trying all combinations of the selected parameters. The Taguchi method, by using orthogonal array, provides the opportunity to get better results with less trials in product quality/process improvement. By taking into account the S/N (Signal to Noise) ratios obtained as a result of the analysis of the designed experiment, parameters that give a solution close to the optimum are determined [6]. Within the scope of the study, experiments were designed according to the L9 standard orthogonal array for three parameters (sodium hydroxide, hydrogen peroxide and weft yarn type) each with three different levels. The factors and levels used in the design phase are given in Table 1.

Table 1. Factor levels

Parameter / Level	1.Level	2.Level	3.Level
A (Sodium Hydroxide g/L)	1	3	5
B (Hydrogen Peroxide g/L)	1	3	5
C (Weft Yarn Type)	Nettle	Cotton	Linen

The experimental plan designed in line with the factor levels given in Table 1 is shown in Table 2.

Table 2. Experiment plan

Test Number	A	B	C
1	1	1	Nettle
2	1	3	Cotton
3	1	5	Linen
4	3	1	Cotton
5	3	3	Linen
6	3	5	Nettle
7	5	1	Linen
8	5	3	Nettle
9	5	5	Cotton

The effect of selected controllable variables on whiteness index, tear strength and color yield was measured. The outputs of the experiment plan are shown in Table 3.

Table 3. Experiment results

Test Number	CIE Whiteness (0-100)	Tear Strength (N)		Color Yield (K/S)
		Warp	Weft	
1	31.44	19.99	0.01	2.68
2	44.57	11.79	7.99	2.58
3	42.47	14.77	19.17	2.31
4	46.17	12.68	8.09	2.27
5	46.69	13.33	15.38	2.75
6	42.69	20.16	0.01	2.20
7	40.82	12.31	14.71	2.20
8	46.11	16.17	0.01	2.22
9	42.88	10.26	6.83	2.27

It has been determined that the most important parameter affecting the degree of whiteness is the hydrogen peroxide concentration. When the S/N ratios were examined, the best CIE Whiteness value (50.21) was obtained in the experiment under $A_2B_2C_2$ (3 g/L sodium hydroxide, 3 g/L hydrogen peroxide, weft yarn cotton) conditions.

The parameter affecting the tear strength in the warp direction the most was found to be the weft yarn type. When the Mean graph was interpreted, it was determined that $A_1B_3C_1$ (1 g/L sodium hydroxide, 5 g/L hydrogen peroxide, weft yarn is nettle) gave the maximum tear strength (warp direction) of the trial. The warp direction tear strength value was determined as 20.14 N.

According to the mean graph, it was determined that the optimum weft direction tear strength was determined in the case of $A_1B_3C_2$ (1 g/L sodium hydroxide, 5 g/L hydrogen peroxide, weft yarn is cotton). In this case, the weft direction tear strength is 9.31 N.

Optimum color yield at K/S values was obtained in $A_1B_2C_3$ (1 g/L sodium hydroxide, 3 g/L hydrogen peroxide, weft yarn linen). As a result of the estimation, the K/S value was 2.69.

When all the results are evaluated in general, it is concluded that cotton fiber provides a better whiteness index than nettle, while cotton/nettle blended fabrics are more durable. It has been determined that the color yield of the linen fiber blended fabric in medium-dark colors is better. Thanks to the applied method, time and cost savings were achieved.

Keywords: Nettle, bleaching, taguchi method, CIE whiteness, tear strength

REFERENCES

[1] SAMANTA, K.K., ROY, A.N., BAITE, H., DEBNATH, S., AMMAYAPPAN, L., NAYAK, L.K., SINGHA, A. and KUNDU, T.K. Applications of nettle fibre in textile: a brief review, International Journal of Bioresource Science, 2021, vol.8, no.1, pp 39-45.

[2] HUANG, G. Nettle (Urtica cannabina L) fibre, properties and spinning practice. Journal of the Textile Institute, 2005, vol. 96, no.1, pp 11-15.

[3] HARWOOD, J. and GILLIAN, E. Nettle Fibre: Its Prospects, Uses and Problems in Historical Perspective. Textile History, 2012, vol. 43, no.1, pp 107-119.

[4] YAVAS, A., AVINC, O. and GEDIK, G. Ultrasound and Microwave Aided Natural Dyeing of Nettle Biofibre (Urtica dioica L.) with Madder (Rubia tinctorum L.). Fibres & Textiles in Eastern Europe, 2017, vol. 25, no. 4(124), pp 111-124.

[5] VOGL, C.R. and HARTL, A. Production and processing of orginally grown fiber netle (Urtica dioica L.) and its potential use in the natural textile industry. A review, American Journal of Alternative Agriculture, 2003, vol.18, no.3, pp 119-128.

[6] MEZARCIOZ, S. and OGULATA, R.T. Optimization of bursting strength of single jersey fabrics with taguchi orthogonal design. Textile and Apparel, 2010, vol.20, no.4, pp 320-328.

ENVIRONMENTAL IMPACTS OF 100% VIRGIN COTTON AND RECYCLED COTTON/VIRGIN COTTON BLENDED FABRICS

Yaşar Erayman Yüksel[1], **Mehmet Kertmen**[2],**Yasemin Korkmaz**[1]
[1] *Kahramanmaras Sutcu Imam University, Department of Textile Engineering, Kahramanmaras, Turkey*
[2] *İskur Tekstil Enerji Ticaret ve Sanayi A.Ş., Kahramanmaras, Turkey*
mehmet.kertmen@iskur.com

Cotton, which is the most important natural fibre, is a renewable, biodegradable cellulosic fibre. Although the environmental perception of cotton is generally positive for consumers, significant environmental effects occur during its production stages. Main factors such as land use, chemical pesticides, synthetic fertilizer use, irrigation and mechanical harvesting in cotton production damage the environment [1,2]. In the yarn and fabric production stages, electric and heat energy are used in the machines for production and in air conditioners for air conditioning. Environmental impacts caused by fibre production are eliminated with the recycling of cotton. The environmental effects of textile production are calculated through life cycle analysis. There are various studies on life cycle assessment of textiles produced with recycled cotton in the literature. Esteve-Turrillas and Guardia (2017), examined the life cycle analysis of T-shirts containing recycled cotton and virgin cotton. As a result of the study, it was found that the production of recycled cotton was the process creates the least environmental impact [3]. In the study conducted by Spathas (2017), life cycle analysis was made for 4 different recycling processes and the recycled yarns for each process caused less environmental impact in all environmental impact categories compared to virgin yarn samples [4]. The results of the study by Erayman Yüksel and Korkmaz (2023), showed that the usage of recycled cotton created less environmental impact than the usage of BCI cotton in many environmental impact categories [5].

In this study, environmental impacts of 100% virgin cotton and recycled cotton/virgin cotton blended fabrics were investigated using life cycle analysis. Life cycle analysis was carried out with the input and output data in the raw material stage, yarn production and 3-thread knitted fabric production stages. All production parameters were kept constant in order to determine the effect of usage recycled fibre in the life cycle analysis. Ne 30/1 combed yarns from 100% virgin cotton fibres were used as face and binding yarns in the production of 3-thread knitted fabrics. As fleecy yarns, Ne 10/1 open-end yarns made of 100% virgin cotton and 50/50% virgin cotton/recycled cotton were used in conventional and recycled samples, respectively. Environmental impacts were calculated using the CML-IA baseline method in SimaPro® life cycle software for different environmental impact categories.

Based on the results of this study, it was observed that the environmental impacts was reduced in the fabrics containing recycled cotton fibres compared to those containing 100% virgin cotton fibre in all impact categories. The highest reduction rates of approximately 10-11% were determined in terrestrial ecotoxicity, total water use and freshwater ecotoxicity categories with the use of recycled fibre.

Keywords: Life cycle analysis, virgin cotton, recycled cotton, environmental impact.

Acknowledgment: This work was funded by the Scientific and Technological Research Council of Turkey (TÜBİTAK) in Turkey with the project number 5200021.

REFERENCES

[1] BAFFES, J., BADIANE, O., NASH, J. Cotton: Market structure, policies and development issues. In WTO Africa Regional Workshop on Cotton, Cotonou, Benin, 2004, Vol. 2324.
[2] CLAY, J. World agriculture and the environment, a commodity-by-commodity guide to impacts and practices. Washington DC, USA: World Wildlife Fund, Island Press. 2004, p 570.
[3] ESTEVE-TURRILLAS, F. A., de la GUARDIA, M. Environmental impact of recover cotton in textile industry. Resources, Conservation and Recycling, 2017, vol. 116, pp 107-115.
[4] SPATHAS T. The environmental performance of high value recycling for the fashion industry, LCA for four case studies: Master's thesis. Chalmers University of Technology, Department of Energy and Environment. Gothenburg, Sweden, 2017, 67 p.
[5] ERAYMAN YUKSEL, Y., KORKMAZ, Y. Çevre dostu denim kumaş tasarimi ve yaşam döngü analizi. Kahramanmaraş Sütçü İmam Üniversitesi Mühendislik Bilimleri Dergisi, 2023, vol. 26, no. 1, pp 117-125.

A STUDY ON REDUCING THE COLOR DIFFERENCE BETWEEN DYEING IN THE LABORATORY AND DYEHOUSE

Abdulkadir Erçakalli[1], **Belkıs Zervent Ünal**[2]
[1] *Kıvanç Textile / Zeytinli Mah. Turhan Cemal Beriker Bulvarı No: 599 Seyhan, Adana*
[2] *Çukurova University / Textile Engineering Department, Adana*
Kadir.ercakalli@kivanctekstil.com

ABSTRACT

The part that has the greatest importance in terms of usage characteristics and added value of the products produced in the textile sector is the finishing department. Fabrics, which are one of the cornerstones of textile ready-to-wear products, consist of three stages, namely finishing processes in order to create a difference. Coloring from these stages is an important factor in the commercial success of textile products with high fashion content, especially apparel fabrics and home textile products.
Parameters such as color, touch, pattern and cut are effective in the purchasing process of a product. One of the process steps in which these parameters are provided is the coloring process. The main purpose of coloring is to increase the appeal of the finished product and to achieve the desired color. Coloring is applied with two different methods as dyeing and printing, and dyeing processes are more widely used.

It is an important issue that reactive dyeing processes can be done correctly in one go and that they can be repeated in the same color applications in dyehouse enterprises in the textile industry. Reactive dyeing works are first carried out in the laboratory environment in line with the wishes of the customers, and production is started in the operating environment after customer approval. However, when the color studies made in the laboratory are transferred to the enterprise, the problem of color difference is encountered. In this context, in order to solve/reduce the problem, it is necessary to examine the parameters that may cause color difference for each stage. This situation increases the number of applications and causes cost increase, time loss, excessive raw material consumption and labor loss in dyehouse enterprises. In this study, it is aimed to minimize the laboratory-business color compatibility and reproducibility problem, which is the biggest problem of the dyeing adventure that starts in the laboratory in the textile sector and ends in the enterprise. For this purpose, fabrics and colors that were dyed within the program in the enterprise where the study was carried out and that had color difference problems were preferred. Within the scope of the studies, experiments were carried out by making differences on the variables of pH, time, temperature, dyeing and washing place in order to reduce the percentage difference by considering both the laboratory recipe and the existing business recipe. As a result of the applied trials, new prescriptions were created to dye the prescriptions received by the enterprise from the laboratory with a minimum of changes.

The main purpose of the study is to minimize both labor, time, energy and water losses in the competition in the global market, to reach the right result at the first time and to reduce the problems experienced in repeatability.

Within the scope of the experimental study, a viscose/cotton/elastane blend woven fabric was used as a sample, and a fabric with a mixture ratio of 55% viscose, 40% cotton and 5%

elastane was preferred as the sample. Selected construction parameters of the sample fabric are given in Table 1. The determined mixing ratio was achieved by using elastane cotton yarn in the weft and viscose yarn with elastane in the warp during the weaving process.

Table 1. Sample Properties

Weawing Type	2/1 Dimi Z
Weft Density	26 yarn/centimeter
Warp Density	32 yarn/centimeter
Weft Yarn Count	Ne 14/1 cotton + 70 dtex elastane (corespun)
Warp Yarn Count	Ne 28/2 viscose + 70 dtex elastane(ring)
Width - Weight	142 centimeter – 335 gram /meter^2

Within the scope of the study, it is aimed to develop approaches to reduce the change in the amount of dyestuff in the recipe while the color transition is made from the laboratory to the enterprise in the impregnation dyeing method. For this purpose, first of all, the amount of change in the recipe of the colors dyed in a selected textile business was revealed and observations were made on the basis of color. The factors in dyeing in the enterprise and laboratory were revealed. The effects of the parameters of the impregnation dyeing method on the color change were examined by making experiments according to a prepared experiment plan, and solution suggestions were developed to reduce it.

It has been observed that by removing caustic completely from the dyeing recipe in the laboratory environment, the pH value is lowered and deeper colors are obtained. Approximately 40% darker colors were obtained as a result of dyeing the recipe obtained from the laboratory without making any changes in the enterprise. It has been observed that the effect of direct steam in the operating conditions on the color is different from the steam produced by the fixing machine in the laboratory.

Keywords: Dyeing, laboratory dyeing, spectrophotometer, color difference, energy/labor/consumable saving.

THE IMPORTANCE OF FIBER TYPE AND COLOR IN THE ENVIRONMENTAL EFFECTS OF GARMENTS

Sema Bahar Erdem[1], **Nurdan Büyükkamaci**[2], **Şafak Birol**[3]
[1] *Graduate School of Natural and Applied Science, Dokuz Eylül University, Izmir, TURKEY*
[2]*Environmental Engineering Department, Engineering Faculty, Dokuz Eylül University, Izmir – TURKEY*
[3]*TYH Tekstil A.Ş. Izmir – TURKEY*
semabaharerdem@gmail.com

The most important factor that determines the characteristics of the clothes is the type of fabric used [1]. Fashionably dressed people prefer clothes prepared according to the current color and fabric type. Fashion designers can choose different fiber types according to the usage areas of textile products. While producing and dressing fashionable clothing is important in modern societies, a more important issue today is choosing clothing with the least environmental impact. It is a known fact that the textile industry is one of the industries that harm the environment more. Since dressing is a compulsory need for people, producing environmentally friendly clothes and choosing such clothes is an important issue in terms of sustainability approach. It has to be a life philosophy for people to choose products that are less harmful to the environment throughout their life cycle, and accordingly, behaviours need to change [2]. So, in this context, which color fabrics produced with which fiber should be preferred? One of the methods that can be used to find the answer to this question is life cycle analysis (LCA). LCA provides a holistic approach to the assessment of environmental impacts throughout the life cycle of a product or manufacturing process and also allows informed decision making [3,4].

In this study, LCA approach was applied for garments produced from two fiber types (100% cotton and 50% cotton - 50% polyester mix) and three colors (white, tinte and smaragd) to determine the environmental effects of them. LCA studies were carried out depending on the ISO 14040-44 standards [5,6]. Information on textile products whose environmental effects were determined are shown in Table 1.

Table 1. Information of the studied garments

Product No	Functional Unit	Weight of the product	Color of the product
1	A short sleeve polo shirt made of 100% cotton	323 g	White
2	A short sleeve polo shirt made of 50% cotton and 50% polyester fiber	323 g	White
3	A short sleeve polo shirt made of 100% cotton	200 g	Tinte
4	A long sleeve polo shirt made of 50% cotton and 50% polyester fiber	300 g	Tinte
5	A short sleeve polo shirt made of 100% cotton	200 g	Smaragd
6	A long polo shirt made of 50% cotton and 50% polyester fiber	300 g	Smaragd

The functional unit is one polo t-shirt with different unit weights and the system boundary is cradle to gate that involves transport, raw material, yarn, dyeing production, cutting and sewing processes. The life cycle inventory data was collected from field for polo t-shirts produced within various production facilities commissioned by TYH Tekstil. The LCA model was created using the GaBi 10.7 software system developed by PE International. Life cycle impact assessment indicators were determined respectively to the following impact categories, calculated using the CML2001-Aug 2016: abiotic depletion (fossil), acidification potential (AP), eutrophication potential (EP) and global warming potential (GWP).

As a result of the study, the highest GWP values in the life cycle of the analyzed polo t-shirts were determined for tinte, smaragd and white colored 50%-50% cotton-polyester (PET) polo t-shirts, respectively. The use of PET fiber increased the GWP of the product. The GWP value of 50% PET addition relative to 100% cotton fiber increased by 29%, 49%, and 36% for white, tinte, and smaragd color, respectively. It is also determined that the darkening of the color also causes an increase in the GWP value. If the products with the same fibers are compared in terms of color, it was concluded that tinte colored products has a slightly higher environmental impacts than smaragd colored products.

Similar results were also observed for ADP and AP impact categories. Significant energy consumption from crude oil, natural gas and electricity use for polyester fiber production has greatly affected the GWP, ADP and AP. However, when the EP potential effect of the products was examined, it was found that the highest effect was in 100% cotton products. The stage that contributes most to EP is the use of fertilizers and pesticides during cotton growing.

Keywords: textile, LCA, fiber, color

The authors gratefully acknowledge the Scientific and Technical Research Council of Turkey (TUBITAK) - (Project No: 119C078) for financial support.

[1] Hoque, M. S., Hossain, M. J., Rahman, M. M., & Rashid, M. M. Fiber types and fabric structures influence on weft knitted fabrics. Heliyon, 2022, 8(6).
[2] Orzan, G., Cruceru, A. F., Bălăceanu, C. T., & Chivu, R. G. Consumers' behavior concerning sustainable packaging: An exploratory study on Romanian consumers. Sustainability, 2018, 10(6), 1787.
[3] GUPTA, S., PATEL, P., and MONDAL, P. Life cycle analysis (LCA) and economic evaluation of catalytic fast pyrolysis: implication of co-product's end-usage, catalyst type, and process parameters. Sustainable Energy & Fuels. 2022, 6(12), 2970-2988ISO 14040:2006; Environmental management – Life cycle assessment – Principles and framework.
[4] MUTHUKUMARANA, T. T., KARUNATHILAKE, H. P., PUNCHIHEWA, H. K. G., MANTHILAKE, M. M. I. D., and HEWAGE, K. N. Life cycle environmental impacts of the apparel industry in Sri Lanka: Analysis of the energy sources. Journal of Cleaner Production, 2018, 172, 1346-1357.
[5] ISO 14040:2006; Environmental management – Life cycle assessment – Principles and framework.
[6] ISO 14044:2006 Environmental management – Life cycle assessment – Requirements and guidelines.

A STUDY ABOUT THE CORRELATION BETWEEN SEAM FATIGUE AND STATIC FRICTION TESTS FOR AUTOMOTIVE UPHOLSTERY CIRCULAR KNITTED FABRICS

Benamir Fidancı[1], Osman Aydın[2], Emir Baltacıoğlu[3]
[1] *Bursa Uludağ University / Textile Engineering / NOSAB 302. sok. No.1 Nilüfer 16145 Bursa / TÜRKİYE*
[2] *Süleyman Demirel University / Textile Engineering / NOSAB 302. sok. No.1 Nilüfer 16145 Bursa / TÜRKİYE*
[3] *Bursa Uludağ University / Textile Engineering / NOSAB 302. sok. No.1 Nilüfer 16145 Bursa / TÜRKİYE*
Benamir.Caylakoglu@marturfompak.com

ABSTRACT
Automotive seat cover fabrics are typically produced by combining three layers. The face fabric is produced by the technique of weaving or knitting, while the middle layer utilizes polyurethane foam and the back layer is a lightweight fabric defined as lining, scrim or backing fabric. These three layers are bonded together using the flame lamination method to form as three-component composite material. Particularly in high-end cars and sports vehicles seats have more complex shapes according to mid-range vehicles. Knitted fabrics' trimming performances are better than the other fabric production techniques due to their flexibility and also preferred because of better aesthetic concerns. In order to produce of knitted fabric; circular knitting, flat knitting, and warp knitting methods are used. While assembling seat cover with using circular knitted fabric is subjected to significant tensile forces and tensions. These tensions are increased the gap between the seams and/or sewing yarn may cause of the loop damage. Testing results are not acceptable according to automotive testing standards because of gap occurring and/or loop damages. Within the scope of this study, a double jersey circular knitted fabric was produced. Two different chemicals were applied to the fabric and the effect of these chemical applications were evaluated according to automotive testing standards.

Keywords: Seam Fatigue, Circular Knitted Fabric, Seam Breakage, Static Friction

INTRODUCTION

Woven and knitted are two main technologies method for automotive seat cover production. Both these two technology can be divided according to own technology and technique [1]. As shown as Table 1, the percentages of fabric technologies used in automotive seat fabrics. that main fabric technologies used for automotive seat covers are woven velour, flat woven, warp knit tricot, warp knit pile sinker, warp knit double needle bar raschel, and circular knit [2].

Table 1. Relative volume of different seating fabrics [3]

Fabric Type	Europe	USA	Asia
Flat Woven	47%	14%	12%
Woven Velour	1%	30%	24%
Warp Knit Tricot (including Pol)	15%	11%	44%
DNBR	5%	23%	9%
Circular Knitted	21%	1%	7%
Leather	11%	21%	4%
Total	**100%**	**100%**	**100%**

Both warp and weft knitting technologies are used to generate numerous types of structures in automotive fabrics. For getting flat and pile fabrics, tricot machines, double needle bar warp knitting machines and in double jersey circular knitting machines can be used. For better trimmability, assembling and fabric flexibility can be combined. Within this combination, seat cover may meets with automotive testing standards. Knit are perceived by the automotive industry to deliver the desirable characteristics of low cost, low weight and high performance [4]. According to The European automotive industry thinks that knitting fabric design flexibility, stretch characteristics, appearance and comforts are good opportunity to use for seat cover trimming. This design flexibility can provide the short-term type of color and pattern complexity with the minimum transition time required by European markets [5]. The stretching feature of knitted fabrics provides ease of application, especially in shaped parts such as headrests and molded parts such as headlining and door panels [6].

Due to the flexibility characteristics of circular knitted fabrics, seam problems may arise during assembly processes and the creation of shaped parts. To test the seam durability, seam fatigue test and static friction tests are performed. As a result of the tests application, the seam durability of the produced circular knitted fabric, such as seat covering is determined.

MATERIAL AND METHOD

As the beginning of the study, fabric selections were made. A fabric that is currently produced for a Main Automotive Manufacturer and has encountered issues in the seam fatigue test was chosen. Fabric production was carried out by Mayer&Cie double jersey circular knit machine. Subsequently, finishing processes were applied. Fabrics were washed at 70°C as open-width. Fabrics are which is finishing were done, two different chemical applied to the fabric as shown as Table 2. Also, chemical-free application were done for the comparison.

Table 2. Chemical Application in Detail

	Chemical Application Step		
Samples	**Chemical**	**g/Lt**	**Temperature**
Sample A	Chemical-Free		
Sample B	Polyethylene-based	20 g/lt	140°C
Sample C	Polyacrylate-based	20 g/lt	

After the fabric production process were completed, the testing phase was initiated. In the testing phase, two different tests were performed: seam fatigue test and static friction test.

Seam fatigue test is performed for determining the seam durability during the trimming. Seam fatigue test is performed to the fabric's length, width and crossed ways. Testing samples are cutted from fabric, placed the machines jaws and machine start to moves in horizontal way. When the testing is completed, gap measurements were taken and it needs to be checking if there any seam breaking. The following images show the seam fatigue device.

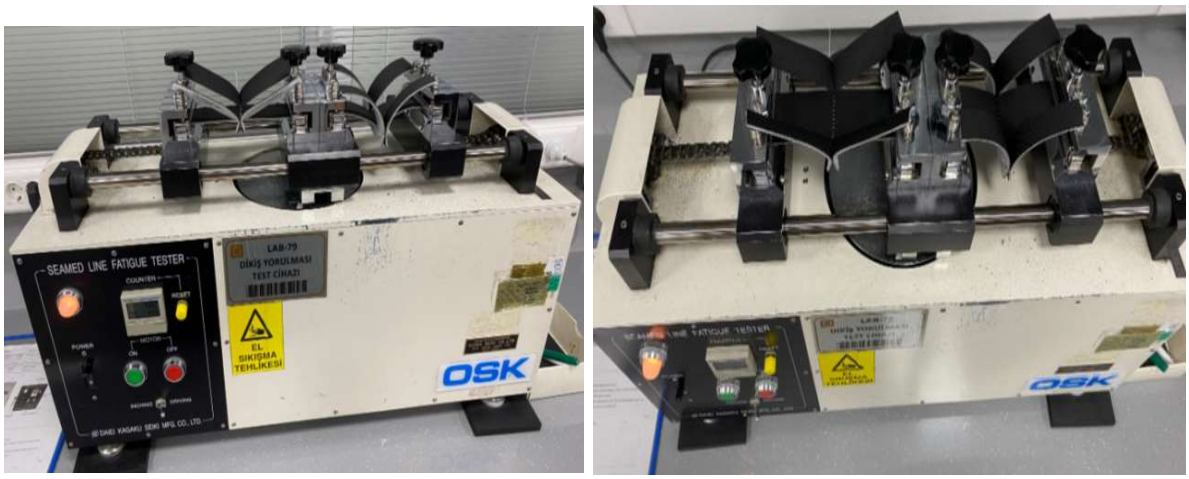


Figure 1. Seam Fatigue Testing Device

Static friction tests are performed for determined the slipperiness of the fabric. This testing is related to seam fatigue test results. Test samples are cutted from fabric as a length, width ways. Fabric placed on machine. Standard test fabric covered weight placed on to fabric. Movable plate start to rise at an angle. Machine shows the angle which is the weight slides from fabric at the end of the testing. The following images show the static friction device.

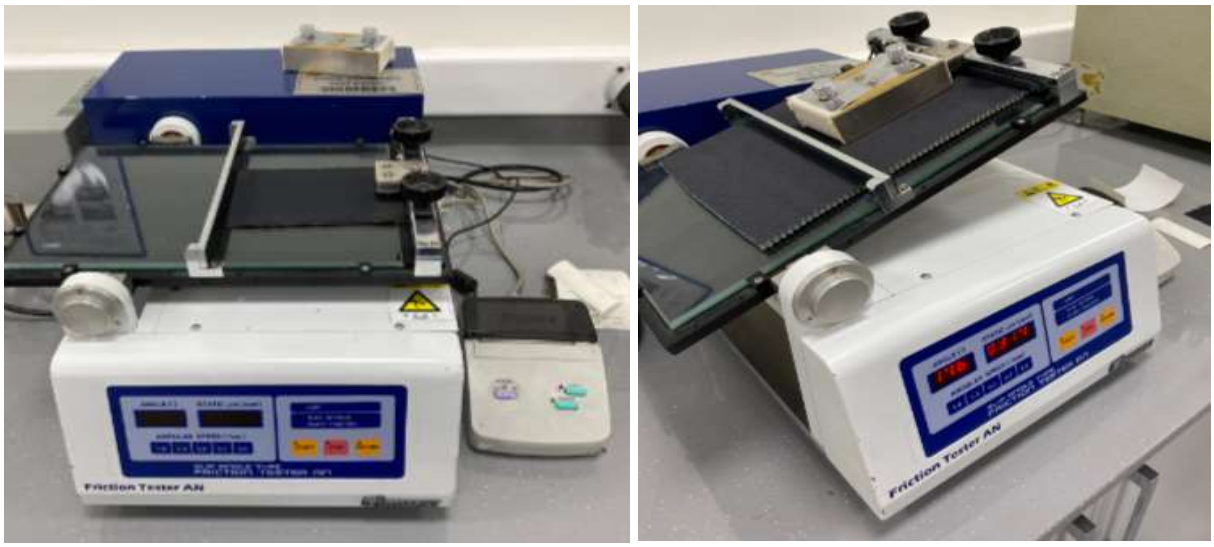


Figure 2. Static Friction Testing Device

RESULTS

Seam fatigue and static friction test results are given as Table 3.

Table 3. Seam Fatigue Test Results

	Sample A		**Sample B**		**Sample C**	
	L Direction	T Direction	L Direction	T Direction	L Direction	T Direction
100 cyc	1,5 mm	1,5 mm	1,5 mm	1,5 mm	2,0 mm	2,5 mm
1500 cyc	1,0 mm	1,5 mm	1,5 mm	1,5 mm	2,0 mm	2,0 mm
	Seam Break Status		**Seam Break Status**		**Seam Break Status**	
	L Direction	T Direction	L Direction	T Direction	L Direction	T Direction
100 cyc	Breakage	No Break	No Break	No Break	Breakage	Breakage
1500 cyc	Breakage	No Break	No Break	No Break	Breakage	Breakage

As shown on the Table 3, Sample A has the seam breakage on the L direction. Seam gap measurement results are in the acceptable range.

Sample B has the best test results. Fabric has no seam breakage and seam gap measurements are acceptable according to the automotive testing standards.

Sample C has the seam breakage on the L and T direction and seam gap measurement is out of the range according to the automotive testing standards.

Table 4. Static Friction Test Results

	Sample A	**Sample B**	**Sample C**
L Direction	23,8°	17,6°	25,8°
T Direction	23,5°	22,9°	36,1°

As shown on the Table 4, Sample B's sliding angle is the lowest angles comparing the other fabrics. Sample A's angle is the average. Sample C has the highest sliding angle.

CONCLUSION

Within the scope of this study, circular knitted fabric is produced and applied two different chemicals. Seam fatigue and static friction tests were done and evaluated.

Sample A were chemical-free trial and made it for the comparison with Sample B and Sample C to evaluate the effect of chemicals.

Chemicals have effected to the fabrics such as more rigidity, more slipperiness. When the Sample B's test results are evaluated; The fabric which is treated with Polyethylene-Based chemical provides more slippery effect and also it provides ease of sewing and thus seam fatigue test result meets the requirement of the specifications.

When the Sample C's test results are evaluated; Polyacrylate-based chemical is effected to the fabric more rigid and this rigidity cause of the seam break.

When the static friction test results are evaluated in parallel with the above tests results, it was observed that the sliding angle was lower in Sample B which is the surface was slippery, as expected.

REFERENCES

[1] ANAND, S., Developments in Technical Fabrics-Part 1, Knit. Intern., July, 32–35.
[2] HARDCASTLE, M., In the driving seat I, Knit. Intern., July, 51–53 (2001).
[3] ANAND, S. and SHAH, T., Recent Advances in Technical Textiles, in "International" Conference on Textile and Clothing",
[4] FUNG, W., HARDCASTLE, M. (2001). Textiles in Automotive Engineering. Woodhead Publishing Limited, Cambridge, England
[5] Anon.2004b. Weft Knits Drive Forward, Knitting International, July, Vol. 111, Issue 1316, pp. 28-29
[6] RODGERS, S. and POWELL, N., 2006 'Automotive Textile Durability 2D Testing im a 3D Application', Autex Conference Proceedings, June 13, 2006, College of Textiles, Raleigh, N.C.

MACHINE MODIFICATION TO SOLVE COLOR CONTAMINATION PROBLEM IN YARN PRINTING MACHINES

Ferhan Gebeş, Kenan Yildirim

Bursa Technical University / Ormo Yün İplik San.(Orhangazi/BURSA)
fgebes@ormo.com.tr

Hand Knitting yarns are generally soft twisted, bulky and thick yarns that are produced from acrylic fiber. (1) These products are manufactured by running a sequential series of processes which are stretch tow breaking, carding, process in the draw frame machine, yarn cleaning, folding and twisting, yarn printing, fixation and balling. Dyeing processes of this yarns can be done in different methods, one of this method is yarn printing dyeing. In this method, yarn can be dyed 6 different colors by using changeable pattern length by using dyeing machine as seen from Figure 1.

Figure 1: Yarn print dyeing

Figure 2: Knitting fabric sample which produced from print dyeing yarn

Hand knitting yarns are produced from acrylic fibers so that basic dyestuff are used as a dyestuff. During dyeing process, dye path are transferred to the yarns by roller printing method and then drying-fixing processes is applied. After these operations, the colored yarn is transferred to the hank parts. In machines with 6 printing cylinders, 6 different colors can be applied onto the yarn so the yarn can be dyed in 6 different colors within yarn length.

After dyeing process, some dyestuff not reacted with fiber molecular structure or hydrolyzed in the dye bath. As a result of this situation, the result of color fastness can be low, the migration of dyestuff can be high.(2,3) After dyeing with basic dyestuff, some unfixed dyestuff can stay on the fiber. So that reason it causes color contamination on the other yarn.(4)

In case of this type of dyeing procedure there is no color contamination problem if color difference in short patterns. But it has been observed that there is color contamination in the yarns in case of color difference in long patterns. This problem can be seen especially sequence in dark&light color tones.

The mentioned problem appears as a major mistake on the fabric after knitting operation.(Figure 4) This problem causes customer dissatisfaction and losing market share. For the solution of this problem, different alternatives has been considered in the company like that production speed has been reduced to increased the fixation time, but the solution increased the production cost and the problem could not be solved permanently.

Figure 3: Print dyed yarn on the hank winder

Figure 4: contamination of the white yarn by red dyestuff

Unfortunately the problem continues to happen at different times. The other solution is modification of the print dye machine winding system. The last solution is topic of this manuscript. By this study the shaper mechanism which transferred the yarn to the hank mechanism on the machine, converted to computer controlled system which cause automatically color changing detection. By using this type of winding mechanism each color has been transferred in different length and different area on the hank wheel. (Figure 5) The detection can be made from machine setup and drive the motor which drive the yarn winding carriage

By this way, color contamination of the yarns under temperature and pressure is prevented, because of not wrapping colors on each other.(Figure 6)

Figure 5: Skein on the hank as divided based on the color by modified machine

Figure 6: Knitting fabric from print dyeing yarn produced by modified machine setup

REFERENCES

[1] Ormo Yün İplik San. Ve Tic. Aş. Kalite Yönetim Sistemi-Süreçler/ Tarama, Üretim, Boyahane.

[2] LIN L., RAMHAN Z., WEN S., NAVIK R., ZHANG P., CAI Y., (2016) Improvement of Colour Fastness for Deep Blue Shade of Cotton Fabric, 4th International Conference on Machinery, Materials and Computing Technology, Çin

[3] Tekstil Teknolojisi Selülozu Boyama 1. (2011). EriĢim: 01 Ocak 2019,http://www.megep.meb.gov.tr/mte_program_modul/moduller_pdf/Sel%C3%BClozu%20Boyama%201.pdf.

[4] UDDIN, M. G. & ISLAM, M. (2015). Effects of Different Soaping and Fixing Agents on Washing Fastness of Reactive Dyed Cotton Fabric, Journal of Multidisciplinary Engineering Science and Technology, 2 (1), 57-61.

THE OPTIMIZATION STUDY ON TREATMENT OF DENIM FABRICS WITH SOL-GEL METHOD

Ayşe Genç[1], Cem Güneşoğlu[2], Mehmet Yüceer[3]
[1] *ÇALIK DENIM Tekstil San. Tic. A.Ş., R&D Department / Yeşilyurt-Malatya, Turkey*
[2] *Gaziantep University / Gaziantep, Turkey*
[3] *İnönü University / Malatya, Turkey*
ayse.korkmazgenc@calikdenim.com

ABSTRACT

The market share of multi-functional textiles with high value-added, different and attractive functionalities is increasing compared to conventional textiles. With sol-gel method, many functional properties that cannot be obtained by conventional methods can be added to textile materials and multifunctional fabrics can be produced easily. As it is known, denim fabric is mainly characterized by certain physical properties like high abrasion and tear resistance compared to frequently used cotton fabrics such as gabardine or poplin produced from cotton yarn. Therefore it has been produced for work wear and sportswear for many years. In recent years, various processes (coating / lamination, ozone fading, laser finishing, sandblasting, resin finishing, etc.) are applied to the denim product in order to give a new look or functionalities. However, none of these processes exceeded the multifunctional properties expected from the sol-gel method. Flame retardant sol-gel coating was first reported by Hribernik using tetraethoxysilane (TEOS) as initiator on viscose fibers. Thermal stability can be improved, as the silica coating can increase the decomposition temperature and prevent oxygen from producing volatiles. Next, Alongi et al., investigated TEOS' effect on thermal stability and flame retardancy of textile fabrics including polyester, cotton and their blends in more detail. They found that this sol-gel treatment can effectively increase the flame retardancy of cellulose-based textiles by increasing thermal stability and strongly reducing heat release. Grancaric et al. found that TEOS and urea/ammonium polyphosphate have good synergistic effect and excellent flame retardancy can be obtained with an LOI value of 44% (S. Wang et al., 2021). Lin et al. applied in-situ sol-gel coating using ammonium polyphosphate (APP), tetraethoxysilane (TEOS) and hydroxy polydimethyl siloxane (HPDMS) to impart flame retardancy and superhydrophobic properties to cotton fabric. They examined that the obtained fabric exhibits significant flame retardancy, superhydrophobicity and self-cleaning properties thanks to the in-situ method (Lin et al., 2019). Xu and his team synthesized α-aminodiphosphonate to provide flame retardant properties with silicon-phosphorus-nitrogen synergy to cotton fabric. After coating this synthesized component on the fabric surface with the sol-gel method, they were dried at 100°C and cured at 180°C. They experienced that the LOI value of the fabric they obtained decreased by 1 point compared to the control fabric and was 27.5%, but gained self-extinguishing property. At the same time, they observed that the LOI value of this fabric decreased to 24.3% after 30 washes (Xu et al., 2020).

All these studies also pointed the high contribution of sol-gel process parameters like drying, condensation temperature, pH of the bath and the precursor type. This study aimed to optimize the process parameters of sol-gel method to be applied to improve the flame retardancy and water repellency of denim fabrics. It helped to find out the best applicable parameters of drying and condensation to utilize for usage at industrial scale.

Key words: Sol-gel, denim fabric, super hydrophobic

MATERIALS AND METHODS

Materials

The denim fabric properties used in this study are given in Table 1.

Table 1. Denim sample properties

Fiber composition	Woven type	Warp x weft density (ends and picks/cm)	Warp Yarn Number (Ne)	Weft Yarn Number (Ne)	Weight (g/m^2)
97% : 3%, cotton : elastane	3/1 Z	21x18	14/1	18/1	275

The fabrics were supplied after caustic soda scouring by Çalık Denim A.Ş.. / Malatya.

For the experimental plan, which is determined by the Design Expert, the input values were selected as drying / condensation (temperatures and duration) and commercially available water repellent chemical as additive. Other parameters like pH, pre-cursor type and pre-cursor : solvent molar ratio were removed not to result with any negative effect on hydrophobic performance. So, the recipe given in Table 2 were applied onto denim fabric sample with the input variations given.

Table 2. Recipe to be used for process optimization of water-repellent sol-gel bath

Ethanol	50 ml
TEOS	8 ml
Water	35 ml
HCl (0,01 N)	15 ml
HDMS	4 ml
GPTMS	11 ml
Urea	2 ml
Tween 20	2 ml
Commercial water repellant	A ml

Variation conditions for drying:
90 ^{0}C 15 min - 100 ^{0}C 10 min - 110 ^{0}C 5 min
Variation conditions for condensation:
170 ^{0}C 75 sec – 150 ^{0}C 5 min - 130 ^{0}C 20 min
Variation requirements for commercial water repellent chemical product:
0 ml – 3 ml – 5 ml

The minimum number of experiments and conditions to be applied in order to use the variation conditions determined according to the Design Expert supported mathematical modeling in the optimization study are given in Table 3.

Table. 3. Experimental Conditions

Experiment number	Drying Temp. (^{0}C)	Drying time (min)	Cond.Temp. (^{0}C)	Cond. Time (min)	Commercial WR Chemical (mL)
1	94,05	15,00	138,11	10	3,99
2	90,00	15,00	150,00	5	2,50
3	94,05	15,00	161,89	2,5	3,99
4	105,95	7,00	138,11	10	1,01
5	100,00	10,00	130,00	20	2,50
6	105,95	7,00	161,89	2,5	3,99
7	100,00	10,00	150,00	5	2,50
8	105,95	7,00	138,11	10	3,99
9	100,00	10,00	150,00	5	0,00
10	94,05	15,00	138,11	10	1,01
11	110,00	5,00	150,00	5	2,50
12	100,00	10,00	150,00	5	2,50
13	100,00	5,00	150,00	5	2,50
14	105,95	7,00	161,89	2,5	1,01
15	100,00	10,00	150,00	5	5,00
16	100,00	10,00	170,00	1,25	2,50
17	100,00	10,00	150,00	5	2,50
18	100,00	10,00	150,00	5	2,50
19	100,00	10,00	150,00	5	2,50
20	94,05	15,00	161,89	2,5	1,01

The recipe in Table 2. was applied onto the denim fabric samples with the foulard under the conditions given; and the padding, drying and condensation processes are repeated 3 times. The fabric samples are then tested for the contact angle and the water repellency tests (output data) according to ISO 4920.

It has been shown that in the sol-gel trials applied to denim fabrics a contact angle of around 135 ^{0}C can be obtained when the drying temperature is between 100 – 105 ^{0}C , the drying time is between 7 – 12 minutes and the addition of a low amount of commercial water repellent.

REFERENCES

[1] BENTIS, A., BOUKHRISS, A., & GMOUH, S. (2020). Flame-retardant and water-repellent coating on cotton fabric by titania–boron sol–gel method. Journal of Sol-Gel Science and Technology, 94(3), 719–730. https://doi.org/10.1007/s10971-020-05224-z
[2] CHAILLOT D., J. MIEHE-BRENDLE, S. BENNICI (2019), Insights on the influence of the precursors on the sol-gel synthesis of hybrid organiceinorganic saponite-like materials, Comptes Rendus Chimie, 22, 258-268
[3] FAN, D. D., YOU, F., ZHANG, Y., & HUANG, Z. (2018). Flame Retardant Effects of Fabrics Finished by Hybrid Nano-Micro Silica-based Sols. Procedia Engineering, 211, 160–168. https://doi.org/10.1016/j.proeng.2017.12.124

[4] HEIMAN-BURSTIEN, D., A. DOTAN, H. DODIUK, S. KENIG. (2021). Hybrid Sol–Gel Superhydrophobic Coatings Based on Alkyl Silane-Modified Nanosilica, Polymers 13, 539. https://doi.org/10.3390/polym13040539
[5] JINDASUWAN, S., SUKMANEE, N., SUPANPONG, C., SUWAN, M., NIMITTRAKOOLCHAI, O., & SUPOTHINA, S. (2013). Influence of hydrophobic substance on enhancing washing durability of water soluble flame-retardant coating. Applied Surface Science, 275, 239–243. https://doi.org/https://doi.org/10.1016/j.apsusc.2012.12.139
[6] KUNDU, C. K., WANG, X., HOU, Y., & HU, Y. (2018). Construction of flame retardant coating on polyamide 6.6 via UV grafting of phosphorylated chitosan and sol–gel process of organo-silane. Carbohydrate Polymers, 181(November), 833–840. https://doi.org/10.1016/j.carbpol.2017.11.069
[7] KUNDU, C. K., WANG, X., LIU, L., SONG, L., & HU, Y. (2019). Few layer deposition and sol-gel finishing of organic-inorganic compounds for improved flame retardant and hydrophilic properties of polyamide 66 textiles: A hybrid approach. Progress in Organic Coatings, 129(August 2018), 318–326. https://doi.org/10.1016/j.porgcoat.2019.01.010
[8] LI, S., LIN, X., LI, Z., & REN, X. (2019). Hybrid organic-inorganic hydrophobic and intumescent flame-retardant coating for cotton fabrics. Composites Communications, 14, 15–20. https://doi.org/https://doi.org/10.1016/j.coco.2019.05.005
[9] LIN, D., ZENG, X., LI, H., LAI, X., & WU, T. (2019). One-pot fabrication of superhydrophobic and flame-retardant coatings on cotton fabrics via sol-gel reaction. Journal of Colloid and Interface Science, 533, 198–206. https://doi.org/https://doi.org/10.1016/j.jcis.2018.08.060
[10] LIU, J., DONG, C., ZHANG, Z., SUN, H., KONG, D., & LU, Z. (2020). Durable flame retardant cotton fabrics modified with a novel silicon–phosphorus–nitrogen synergistic flame retardant. Cellulose, 27(15), 9027–9043. https://doi.org/10.1007/s10570-020-03370-9
[11] QIN, R., SONG, Y., NIU, M., XUE, B., & LIU, L. (2020). Construction of flame retardant coating on polyester fabric with ammonium polyphosphate and carbon microspheres. Polymer Degradation and Stability, 171, 109028. https://doi.org/https://doi.org/10.1016/j.polymdegradstab.2019.109028
[12] ŠEHIĆ, A., TOMŠIČ, B., JERMAN, I., VASILJEVIĆ, J., MEDVED, J., & SIMONČIČ, B. (2016). Synergistic inhibitory action of P- and Si-containing precursors in sol-gel coatings on the thermal degradation of polyamide 6. Polymer Degradation and Stability, 128, 245–252. https://doi.org/10.1016/j.polymdegradstab.2016.03.026
[13] SPONTONI M., D. ESTENOZ, G. LLIGADAS, J.C. RONDA, M.GALIA, V. CADIZ (2012), Synthesis and characterization of a hybrid material based on a trimethoxysilane functionalized benzoxazine, Journal of Applied Polymer Science, 126, 4, p. 1369-1376
[14] WANG, S., XU, D., LIU, Y., JIANG, Z., & ZHU, P. (2021). Preparation and mechanism of phosphoramidate-based sol-gel coating for flame-retardant viscose fabric. Polymer Degradation and Stability, 190, 109620. https://doi.org/https://doi.org/10.1016/j.polymdegradstab.2021.109620
[15] WANG, X., LU, Y., ZHANG, Q., WANG, K., CARMALT, C. J., PARKIN, I. P., ZHANG, Z., & ZHANG, X. (2021). Durable fire retardant, superhydrophobic, abrasive resistant and air/UV stable coatings. Journal of Colloid and Interface Science, 582, 301–311. https://doi.org/10.1016/j.jcis.2020.07.084
[16] XU, D., GAO, Z., XU, B., REN, H., ZHAO, X., ZHANG, Y., WANG, S., JIANG, Z., & ZHU, P. (2020). A facile and effective flame-retardant coating for cotton fabric with α-aminodiphosphonate siloxane. Polymer Degradation and Stability, 180, 109312. https://doi.org/https://doi.org/10.1016/j.polymdegradstab.2020.109312

[17] ZHANG, A.-N., ZHAO, H.-B., CHENG, J.-B., LI, M.-E., LI, S.-L., CAO, M., & WANG, Y.-Z. (2021). Construction of durable eco-friendly biomass-based flame-retardant coating for cotton fabrics. Chemical Engineering Journal, 410, 128361. https://doi.org/https://doi.org/10.1016/j.cej.2020.128361
[18] ZHANG, D., WILLIAMS, B. L., SHRESTHA, S. B., NASIR, Z., BECHER, E. M., LOFINK, B. J., SANTOS, V. H., PATEL, H., PENG, X., & SUN, L. (2017). Flame retardant and hydrophobic coatings on cotton fabrics via sol-gel and self-assembly techniques. Journal of Colloid and Interface Science, 505, 892–899. https://doi.org/10.1016/j.jcis.2017.06.087
[19] ZHU, Y. S., YOU, F., ZHOU, H. T., HUANGFU, W. H., & WANG, Z. H. (2018). Pyrolysis Properties and Flame Retardant Effects of Fabrics Finished by Hybrid Silica-based Sols. Procedia Engineering, 211, 1091–1101. https://doi.org/10.1016/j.proeng.2017.12.114

A STUDY ON THE EFFECT OF ABRADANT TYPE ON THE PILLING PERFORMANCE OF BLENDED FABRICS

Funda GÖKSEL, Seray TOPRAK
TUBITAK Bursa Test and Analysis Laboratory, Bursa-TÜRKİYE
funda.goksel@tubitak.gov.tr

ABSTRACT

Pilling is a fabric surface defect resulted by regular wear-cleaning cycles, giving an unsightly appearance. Pills are formed by the entanglement of loose fibers protruding from the fabric surface during wear, washing and rubbing. It can be affected by different factors such as fiber, yarn and fabric structural properties as well as applied finishing processes. Accordingly, it is aimed to compare two distinct abradants (standard wool fabric and the specimen fabric) on the pilling performance of three blended fabrics (one woven and two knitted) with different constructions and compositions.

Keywords: Pilling, Martindale, Abrasive, Fabric

MATERIALS AND METHODS

Pilling is a condition that arises in wear due to the formation of little 'pills' of entangled fiber clinging to the fabric surface giving it an unsightly appearance. Pills are formed by a rubbing action on loose fibers which are present on the fabric surface [1].

Pill formation consists of three stages due to mechanical impact to the surface of rasped products, primarily, the tips of several fibers of fiber are pulled out creating a fuzzy surface. Later on, broken fibres grip to felt tips and forms separate, gradually growing pills [2].

New garments made from cotton and cotton-blend fabrics often have a hand that is rather hard and stiff. The garment surface is not smooth, since small fuzzy microfibrils protrude from it. Additionally, after a relatively short period of wear, pilling will appear on the garment surface, thereby giving it an unappealing and worn look [3].

In order to determine the impacts of fabric and abradant type on the pilling performances, knitted Cotton fabric (320 g/m^2), knitted Cotton/Elastane fabric (192 g/m^2), and woven Polyester(PES)/Cotton fabric (114 g/m^2) were used. Pilling tests were conducted according to EN ISO 12945-2 Martindale method [4]. 6000 cycles of pilling process was applied to the fabrics. Three different fabrics were each tested with both wool fabric and its own specimen as abradant. Visual assessments (pilling, fuzzing, and matting grades) were evaluated according to EN ISO 12945-4 [5]. Images of tested and evaluated fabrics are given in Figure 1.

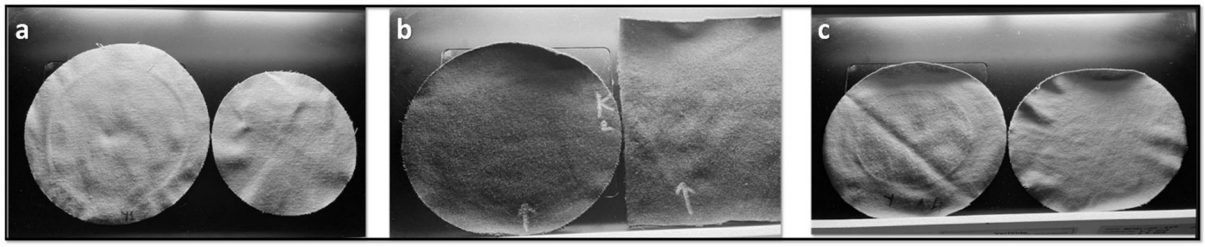


Figure 1. Images of tested and evaluated fabrics
(a) PES/Cotton woven fabric, (b) Cotton knitted fabric, (c) Cotton/Elastane knitted fabric)

RESULTS AND DISCUSSSION

In this study, pilling performances were evaluated at 6000 rubs according to the new pilling standards [4,5] in three assessment stages: pilling, fuzzing and matting. Each surface appearance was recorded by using two abradants. The grades of each test specimen in all three fabrics is summarized in Table 1.

Table 1. Determination of fabrics propensity to surface pilling, fuzzing, matting according to abradant type

	Number of Pilling Rubs	Pilling	Fuzzing	Matting	Abradant Type
PES/COTTON Blue Fabric (Woven) 114 g/m²	6000 rev.	3-4	3	4	Standard wool fabric
	6000 rev.	3-4	3	4	Standard wool fabric
	6000 rev.	2-3	3	4-5	Test sample
	6000 rev.	2	2-3	4	Test sample
COTTON Black Fabric (Knitted) 320 g/m²	6000 rev.	4-5	3-4	4-5	Standard wool fabric
	6000 rev.	4-5	3-4	4-5	Standard wool fabric
	6000 rev.	4	4	4-5	Test sample
	6000 rev.	4	4	4-5	Test sample
COTTON/ELASTANE Brown Fabric (Knitted) 192 g/m²	6000 rev.	3-4	3-4	4-5	Standard wool fabric
	6000 rev.	3-4	3-4	4-5	Standard wool fabric
	6000 rev.	3	3	4	Test sample
	6000 rev.	3	3	4	Test sample

Using own fabric as the abradant type, the worst results were obtained for all fabrics in comparison to standard wool fabric. Lower grades were found in fuzzing surface than pilling surface changes. It was considered that choosing cotton as the fiber type, the fiber lengths tended to fuzzing rather than pilling, and there were no fiber mismatches that would increase static electricity. The matting grades were found to be almost the same for all fabrics. As expected in Polyester/Cotton blend fabric, when two different fiber blends are used, it has been observed that the pilling level increases. It has been observed that in knitted cotton fabrics using elastane yarns, elastane yarn increases friction, causing a rise in fuzzing and pilling

CONCLUSION

In this study, pilling performance was evaluated for three fabrics using two different abrasive fabrics. In the pilling test; rubbing against same fabric gave worse results in pilling performance compared to rubbing against standard abrasive wool fabric.

REFERENCES

[1] JAHAN, I. (2017). Effect of Fabric Structure on the Mechanical Properties of Woven Fabrics. Adv Res Text Eng. 2(2): 1018.
[2] BUSILIENE,G., LEKECKAS, K., URBELIS, V. (2011). Pilling Resistance of Knitted Fabrics. Materials Science, Vol.17, No.3, 297-301.
[3] UKPONMWAN,J.O.., MUKHOPADHYAY A. & , CHATTERJEE, K.N., (1998). Pilling, Textile Progress, 28:3, 1-57.
[4] EN ISO 12945-2, (2020), “Textiles – Determination of fabric propensity to surface pilling, fuzzing or matting - Part 2: Modified Martindale method”.
[5] EN ISO 12945-4, (2020), “Textiles – Determination of fabric propensity to surface pilling, fuzzing or matting - Part 4: Assesment of pilling, fuzzing or matting by visual analysis”.

FASHION DIET – CHALLENGES AND POTENTIALS OF OPEN EDUCATIONAL RESOURCES (OER) FOR EDUCATION FOR SUSTAINABLE DEVELOPMENT (ESD) IN TEXTILE EDUCATION

Anne-Marie Grundmeier[1], Mirela Blaga[2]
[1]University of Education Freiburg, Germany
[2]Gheorghe Asachi Technical University, Romania

Within the framework of a sustainable transformation, a reorientation of established production techniques and products, consumption patterns and lifestyles is demanded (United Nations, 2015). Companies are called upon to recognise sector-specific challenges to sustainability and to develop socially responsible solution strategies. Nevertheless, a green transformation cannot be successful without informed and sustainable consumers.

To support students and pupils in classifying the relevance of their actions for the environment and society, targeted educational offers in the sense of Education for Sustainable Development (ESD) are needed. ESD represents a pedagogical action concept to enable learners to make judgements and take action in everyday life and at work, and to make a contribution to shaping sustainable development (Rieß et al., 2022).

A strong demand for sustainable products and processes in the textile and fashion industry and its global markets imposes a continuous implementation of the guiding principle ESD in textile education and industry. To achieve this goal, the European project Fashion DIET (Sustainable Fashion Curriculum at Textile Universities in Europe – Development, Implementation and Evaluation of a Teaching Module for Educators) developed teaching and learning materials for an e-learning platform, based on a partnership of a university of education and three universities with textile departments (project duration: 09/2020 - 08/2023). A further education module on ESD for higher education in the context of fashion and textiles was elaborated with a three-part module comprising 42 lectures on didactic-methodical concepts, sustainable fashion design and production technologies as well as a sustainable orientation of the fashion market. Another outcome are teaching and learning materials for school education, based on selected lectures of the ESD module.

Through educational and communication processes, challenges of sustainable development in the textile and fashion industry and its market can be reflected upon. An understanding of the complex, multi-layered interrelationships between ecological, economic, social, cultural and political conditions for sustainable development can be built up and deepened, and values and attitudes can be questioned. This can initiate or deepen a change in consciousness and contribute to the individual development of competencies that motivate people to get involved and enable them to responsibly shape the present and the future.

Overall, 40 percent of young people in Germany are thinking about how they can behave in a more climate-friendly way. 37 percent are more concerned about the future, 34 percent are trying to get friends and family to act in a more climate-friendly way and 28 percent want to get (even) more involved in environmental and climate protection in the future (BMUV & UBA, 2021). It is therefore important to present students with sustainable, feasible options for action or motivating solutions. This finding is supported by Ojala's study (2015) that teachers should take students' emotions seriously and communicate in a forward-looking, positive and solution-oriented way.

Therefore, the curricular implementation of ESD in all study programmes is demanded (Molitor et al., 2023). The promotion of the necessary skills of knowledge acquisition, critical reflection,

autonomous decision-making and action is also a task of teacher education. Vocational education and training are seen as the key to the sustainable transformation of the professional world. The aim of vocational education and training for sustainable development is to promote competences with which the working and living environment can be shaped in the sense of sustainability.
The ESD-related teaching and learning materials of the project Fashion DIET are provided as Open Educational Resources (OER) via Glocal Campus, an open access e-learning platform, that enables virtual collaboration between universities. A second platform is the Fashion and Textile Database, a comprehensive database to collect up-to-date information on fashion and textile related topics. Fashion DIET thus strengthens the quality and relevance of sustainability-oriented fashion design, textile and clothing engineering as well as management education.

Keywords: curricula, fashion design, ESD, OER, textile and clothing technology

REFERENCES

[1]. Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz (BMUV) & Umweltbundesamt (UBA) (Eds.). (2021). Zukunft? Jugend fragen! – 2021. Umwelt, Klima, Wandel – was junge Menschen erwarten und wie sie sich engagieren [Future? Ask the Youth! - 2021. environment, climate, change - what young people expect and how they get involved]. https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/zukunft_jugend_fragen_2021_bf.pdf
[2]. MOLITOR, H., KRAH, J., REIMAN, J., BELLINA, L., & BRUNS, A. (2023). Zukunftsfähige Curricula gestalten - eine Handreichung zur curricularen Verankerung von Hochschulbildung für nachhaltige Entwicklung [Designing sustainable curricula - a handout on the curricular anchoring of higher education for sustainable development]. Hochschule für nachhaltige Entwicklung Eberswalde. https://doi.org/10.57741/opus4-388
[3]. OJALA, M. (2015). Hope in the Face of Climate Change: Associations With Environmental Engagement and Student Perceptions of Teachers' Emotion Communication Style and Future Orientation. The Journal of Environmental Education, 46(3), 133–148. https://doi.org/10.1080/00958964.2015.1021662
[4]. RIEß, W., MARTIN, M., MISCHO, C., KOTTHOFF, H.-G., & WALTNER, E.-M. (2022). How Can Education for Sustainable Development (ESD) Be Effectively Implemented in Teaching and Learning? An Analysis of Educational Science Recommendations of Methods and Procedures to Promote ESD Goals. Sustainability, 14, 3708. https://doi.org/10.3390/su14073708
[5]. United Nations General Assembly UN (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. Resolution Adopted by the General Assembly on 25 September 2015, 42809, 1-13. https://doi.org/10.1007/s13398-014-0173-7.2

SPORTSWEAR COLLECTION DEVELOPED FROM PULP BASED BIODEGRADABLE REGENERATED CELLULOSE FIBERS

Buket GÜLER[1], Ayşegül KAYA[1], Rengin GÜREL[1], Şeyma SATIL[2], Tülin KAYA NACARKAHYA[2]

[1] *TYH Uluslararası Tekstil Pazarlama San. Tic. A.Ş., 34197 İstanbul, Turkey*
[2] *Karafiber Textile Research and Development Center, Gaziantep, Turkey*
buketguler@tyh.com.tr

As people's welfare and cultural levels increase, their desire for better quality and various clothing increases rapidly due to their desire to live better and more comfortably, and the amount of fiber consumed per capita in the world increases rapidly. Since the production of natural fibers could not increase due to the increase in the world population, the resulting gap will be filled with man-made fibers [1]. Today, many chemical fibers are produced as an alternative to cotton fiber, which is a natural fiber. One of the most important of these fibers, called regenerated cellulosic fibers, is viscose. Although viscose is the most produced and consumed regenerated cellulose fiber today, its low wet strength property has led to the development of modal fiber. Then, lyocell fiber produced with solvent N-Methylmorpholine N-oxide (NMMO) that does not harm the nature with different production methods started to be produced [2].

Within the scope of this study, three-thread fabrics in different blends will be produced with biodegradable regenerated cellulose fibers based on pulp dissolved with NMMO. In these blends, hemp, organic cotton, better cotton, polyester, recycle polyester, cotton and elastane fibers were used as raw materials. The aim of the study is to examine and increase the properties of the products obtained from double plate 3 yarn fabrics developed in different mixtures. Pulp-based biodegradable fibers were chosen as raw material for the project because natural fibers could not meet the increasing fiber demand, the demand for regenerated cellulose fibers increased, regenerated cellulosic fibers are more comfortable and healthy fibers compared to synthetics and the innovation potential of these fibers is high.

Lyocell fiber is produced by Tencel® in the world with its large share in the market. Fiber is used by importing in Turkey. With this study, Ecocell® raw material, which is also an import substitute, is being developed by Karafiber Tekstil A.Ş., which was established as Turkey's first lyocell Factory. The mission of this raw material is to protect our nature and promote sustainability without taking pulp from ancient and endangered forests. Rana et al. (2014), discussed the production, properties, applications and sustainability issues of various regenerated cellulosic fibers in their study. They stated that among various regenerated cellulosic fibers, lyocell fiber offers significant environmental benefits. They emphasized that the lyocell fiber is produced from renewable resources and using a solvent that is almost completely recyclable, as well as being completely biodegradable. They stated that the lifecycle assessment (LCA) studies on these fibers show that Lyocell fiber production (especially based on the use of municipal solid waste incineration (MSWI) as a process energy source) has advantages over other regenerated cellulosic fibers due to its lower energy, water and soil requirements as well as lower effects on global warming potential, abiotic depletion, ozone depletion, human toxicity, freshwater ecotoxicity and terrestrial ecotoxicity, acidification, photochemical oxidant formation and eutrophication [3]. Zhang et al. (2018), in their study, compared the production process, environmental effects and product quality of NMMO-based

lyocell fibers with conventional viscose fibers. They stated that, unlike commercial viscose fiber, the NMMO-based lyocell production process is much more environmentally friendly. They also stated that lyocell fibers have unique fiber structure and properties such as fibril orientation and crystallinity and have very high strength compared to viscose fibers [4].

In the scope of the project, knitted fabric samples in different mixtures were developed and fabric compositions are given below.

Sample 1: 30/30/10 Ring 58% Ecocell 7% Hemp 35% Cotton
Sample 2: 30/30/10 Ring 67% Ecocell 33% Cotton
Sample 3:30/30/10 Ring 67% Ecocell 33% Cotton
Sample 4: 30/1 Ring 63% Ecocell 31% Cotton 6% Elastane
Sample 5: 24/1 Ring 85% Ecocell 9% Hemp 6% Elastane
Sample 6: 30/1 Ring 31% Ecocell 63% Cotton 6% Elastane
Sample 7: 30/30/10 Ring 33% Ecocell 67% Cotton
Sample 8: 30/70/20 Ring 42% Ecocell 43% Organic Cotton 15% Recycle Polyester
Sample 9: 30/70/20 Ring 40% Ecocell 40% Organic Cotton 20% Recycle Polyester
Sample 10: 30/70/20 Ring 25% Ecocell 60% Organic Cotton 15% Recycle Polyester
Sample 11: 30/70/20 Ring 30% Ecocell 50% Organic Cotton 20% Recycle Polyester
Sample 12: 30/1 Ring 47% Ecocell 47% Organic Cotton 6% Elastane
Sample 13: 30/30/10 Ring 33% Ecocell 67% Cotton

Physical tests (basis weight, surface appearance, pilling, fastness –washing, water, perspiration and rubbing fastness–, surface appearance after washing, air permeability, burst strength, thickness, dimensional stability, abrasion tests) and characterization will be performed on fabric samples produced within the scope of the study. After the fabric to be used is determined, model drawings will be made as a result of design studies, fit studies, and a sportswear collection will be created from pulp-based biodegradable regenerated cellulose fiber content, which is dissolved with NMMO.

In the study, the blends of lyocell fiber, which is a traceable certified and sustainable fiber produced in a closed-circuit system and with zero waste, with sustainable fibers such as organic cotton, recycle PES and hemp were found to comply with the expected quality standards for use in sportswear. In addition, it has been determined that the ready-made clothing products, sportswear, obtained from the blended fabrics used in the study can be disseminated.

Keywords: Lyocell, knitted fabric, biodegradable, sustainability, sportswear

[1] ARDIÇ, Y. Selülozik Liflerin Farkli Şartlarda Fibrilleşme ve Yorulma Davranişlarinin İncelenmesi. Yüksek Lisans Tezi, Fen Bilimleri Enstitüsü. Bursa, 2007, 164s.
[2] ÖZBAĞCI, Ö. Pamuk ve Bazı Rejenere Selüloz Esaslı Süprem Örgü Kumaşların Fiziksel ve Boyutsal Özellikleri. Yüksek Lisans Tezi, Fen Bilimleri Enstitüsü. İzmir, 2008, 166s.
[3] RANA, S., PICHANDI, S., PARVEEN, S., FANGUEIRO, R. Regenerated Cellulosic Fibers and Their Implications on Sustainability. Roadmap to Sustainable Textiles and Clothing, 2014, 239–276.
[4] ZHANG, S., CHEN, C., DUAN, C., HU, H., LI, H., LI, J., LIU, Y., MA, X., STAVIK, J., NI, Y., Regenerated Cellulose by the Lyocell Process, a Brief Review of the Process and Properties. BioResources, 2018, 13(2), 4577-4592.

EFFECT OF RING YARN MACHINE SPINNING ELEMENTS ON RECYCLE YARN PRODUCTION

Esra GÜNEŞ[1], Cansu GENÇ[1], Kübra BAYKAN[1], Ersen ÇATAK[1], Çağla Deniz ŞENTÜRK[1]
[1]SANKO Textile Research and Development Center / Gaziantep, TURKEY
esra.erici@sanko.com.tr

ABSTRACT

In this study, it was aimed to observe the effects of cot and clip, which are spinning machine spinning elements, on yarn quality and running performance in pre-consumer recycle cotton and regenerated cellulose blended ring yarn production. Within the scope of the study, the fibers brought into fiber form by opening the pre-consumer textile wastes were mixed with regenerated cellulose fiber to obtain a blend and finally ring yarn was produced. During ring yarn production, cots of different hardness and clips with different yarn transition intervals were used. It was seen that up to a certain hardness value, the cot hardness directly proportional affects the working performance of the yarn, but it affects the yarn quality inversely proportional. When the effect of the clip is examined, it has been observed that the yarn transition interval (distance in mm) affects the working performance directly proportional, but affects the yarn quality inversely proportional.

Keywords: recycle, yarn, clip, cot, cotton

INTRODUCTION

As a result of the rapidly increasing population, economy and industry, the increase in the ratio of all kinds of materials used causes an increase in the amount of waste generated. The elimination of wastes without harming the environment and bringing them into the economy has made recycling inevitable. The metals, plastics, papers, textile wastes and other materials used can stay in nature for many years and reduce the fertility of the soil. The recycling rate of textile waste in Turkey is increasing day by day with the efforts of companies and scientific organizations and has reached the level of 70% [1].
Cotton, one of the basic raw materials of textile production, is a natural fiber with a significant environmental impact throughout its entire life cycle. One of the most effective methods of minimizing these environmental effects is recycling [2].
The most important difficulties in cotton recovery in Turkey are the production of thick and low quality yarn with low added value and the low product structure. According to the Council for Textile Recycling, textile recycling materials are classified in two groups as pre-consumer and post-consumer waste. Pre-consumer textile waste; are textile wastes generated during the production of fiber, yarn, textile, technical textile, nonwoven surface, ready-made clothing and shoes [3]. The study was carried out with this material. Post-consumer textile waste; all kinds of clothing and home textile products that the consumer no longer needs and decide to throw away fall into this group [3].

MATERIALS AND METHODS

14/1 Ne and 18/1 Ne yarns were produced on the ring spinning machine from the roving obtained from recycle cotton and regenerated cellulose fiber mixture. Yarn production was done on Zinser Yarn machine. In the experiment, exit cots of different hardness were used. At the same time, clips with different heights of yarn passage intervals were attached and then yarn tests were carried out.
The IPI quality tests of the yarns rolled into bobbins were made on Uster Tester 6 and Uster Tensojet devices.

RESULTS AND DISCUSSION

During the production of recycle cotton and regenerated cellulose fiber blended yarn, the effects of spinning elements such as cots and clips on the yarn quality and working performance in the spinning machine were investigated.
When the effect of the cuffs is observed as a result of the trials; It has been observed that up to a certain cot hardness, the IPI values of the yarns increase as the cot hardness increases, and the yarn IPI values improve as the cot stiffness decreases.

Table 1: The Effect of Cuff Hardness on Yarn IPI Values

Yarn Ne: 18/1 Ring			
Cot Colors	**Cot Hardness (Shore)**	**Yarn U%**	**Yarn U Cv**
Grey Cot	83	17.64	23.48
Brown Cot	75	16.11	21.18
Green Cot	70	15.66	20.79
Red Cot	65	15.99	21.25

* As the numerical value increases, the cot hardness increases

As seen in the table, the values improved as the cot hardness decreased until the red cot with a shore hardness of 65. However, values at 65 shore hardness began to be negatively affected.

Considering the effect of the clip, which is another spinning element; It has been observed that the working performance of the yarn improves as the yarn transition interval (distance in mm) in the clips increases, but the IPI values of the yarn are adversely affected by this situation. Likewise, as the yarn passing range decreases; It has been observed that the IPI values of the yarn have improved, but the working performance has been negatively affected by this situation.

Table 2: The Effect of Yarn Passage Distance on Yarn IPI Values

Yarn Ne: 14/1 Ring			
Clip Colors	**Yarn Transition Interval (mm)**	**Yarn U%**	**Yarn U Cv**
Beige	4.8	17.37	23.36
Green	5.5	18.6	24.96
Violet-pink	6.3	19.3	25.94

CONCLUSION

As a result of the study, it was seen that up to a certain hardness value, the cot hardness directly proportional affects the working performance of the yarn, but it affects the yarn quality

inversely proportional. When the effect of the clip is examined, it has been observed that the yarn transition interval (distance in mm) affects the working performance directly proportional, but affects the yarn quality inversely proportional.
For this reason, it is important to choose the cot and clip to be used depending on the properties of the yarn to be produced, in a way that will keep both the yarn quality and the working performance optimal.

REFERENCES

[1] ERSOY, Y., & ZIRAPLI, M. (2014). Geri Dönüşüm İplikçiliğin Önemi ve İplik Üretim Yöntemleri. *Düzce Üniversitesi Bilim ve Teknoloji Dergisi*, *2*(2), 425-432.
[2] Yurtaslan, Ö. (2018). *Bir tekstil işletmesinde üretilen tekstil teleflerinin çevreci bir yaklaşımla geri kazanımı* (Master's thesis, Bursa Teknik Üniversitesi).
[3] Burçin, E. S. E. R., Çelik, P., Ahmet, Ç. A. Y., & Akgümüş, D. (2016). TEKSTİL VE KONFEKSİYON SEKTÖRÜNDE SÜRDÜRÜLEBİLİRLİK VE GERİ DÖNÜŞÜM OLANAKLARI. *Tekstil ve Mühendis*, *23*(101), 43-60.

UNIVERSAL TEXTILE DESIGN CENTER

Nevin Çiğdem Gürsoy
Textile Engineering Department, Faculty of Textile Technologies and Design, Istanbul Technical University, Istanbul, Türkiye, 34437
gursoyne@itu.edu.tr

This paper is about Universal Textile Design Center, a global movement of inclusive design, initiated at Istanbul Technical University, School of Textile Technologies and Design. The Center was established in 2014 under a grant from Istanbul Development Agency. It is started as a research, information, and technical assistance center at Istanbul Technical University.

The main goal is to make a leadership to improve the quality and design of textiles and textile products for everybody considering the necessities of disabled and elderly people. Main idea is to design easy dress on, easy undress, easy-care, comfortable, functional and aesthetic textiles for all people.

The Center was not active for a while because of the pandemia but it is currently on going now.

Keywords: Universal textile design, universal design, adaptive clothing

PROPERTIES OF NANOFIBROUS POLY(VINYL ALCOHOL) / NAFION POLYMER ELECTROLYTE MEMBRANES

Mert Işılay[1], **Ahmet Çay**[2], **Çiğdem Akduman**[3], **E. Perrin Akçakoca Kumbasar**[2], **Hasan Ertaş**[4]

[1]*Department of Textile Engineering, Graduate School of Natural and Applied Sciences, Ege University, Izmir, Türkiye*

[2]*Department of Textile Engineering, Faculty of Engineering, Ege University, Izmir, Türkiye*

[3]*Denizli Vocational School of Technical Sciences, Department of Textile Technology, Pamukkale University, Denizli, Türkiye*

[4]*Department of Chemistry, Faculty of Science, Ege University, Izmir, Türkiye*

ahmet.cay@ege.edu.tr

The use of clean energy sources is now utmost important for a sustainable world in the fight against climate change and other environmental problems. With the developing technology, it is possible to produce environmentally friendly, reliable and efficient devices. One of them are fuel cells, defined as electrochemical cells in which the chemical energy of the fuel is directly converted into electricity in one-step for power generation. Among several types of fuel cells, polymer electrolyte membrane fuel cells (PEMFC) has found favor because of the advantages such as low operating temperature, high power density, flexibility of fuel type, etc. One of the most important components in PEMFC is the polymer-based membrane, known as the polymer electrolyte membrane (PEM), which acts as an electrolyte for protons and provides proton transfer. Another task of PEM is to prevent the permeation of fuel from the anode to the cathode.

As of today's state of PEMFC technique, Nafion membranes are commercially available and the most widely used membrane material. However due to the several disadvantages of Nafion film membranes such as poor water management, high fuel permeability, etc., studies have focused on the development of alternative new membranes. Among these studies, especially the development of nanofibrous composite membranes has become the focus of attention in recent years.

In this study, poly(vinyl alcohol)/Nafion based nanofibrous composite membranes were produced by electrospinning method. The resultant electrospun nanofibers were thermally stabilized, coated and sulfonated, respectively, to produce composite nanofibrous membranes. SEM, proton conductivity and methanol permeability tests were applied in order to investigate their usability in fuel cells. The results showed that the easily produced and relatively inexpensive nanofibrous PVA/Nafion composite membranes have the potential for direct use in fuel cell applications.

The authors would like to gratefully acknowledge the financial support for this research received through the project (No:FOA-2020-21411) of the Ege University Scientific Research Projects Coordination Unit.

Keywords: Fuel cell, polymer electrolyte membrane, nanofiber, Nafion

EVALUATION OF THE TECHNICAL PERFORMANCE OF AUTOMOTIVE SEAT FABRICS PRODUCED USING POCKET STRUCTURES AND FILLER YARN

Selenay Elif İŞLER[1], Nur Ceyda UYANIKTIR[2], Semih OYLAR[3]
[1,2,3] Martur Fompak International, Textile R&D Department, Bursa, Turkey
ceyda.uyaniktir@marturfompak.com

ABSTRACT

Automotive seat covers are traditionally produced using jacquard and dobby weaving techniques. In the production of these fabrics, high density weave structures are commonly used to achieve successful results in abrasion and strength tests in accordance with automotive specifications. The necessity of meeting the test requirements in automotive seat cover fabrics is one of the factors that limit the design variability. Despite these limitations, customers always demand new design options. When it is predicted that autonomous vehicles will break into the market rapidly, it is believed that the amount of time driver and occupant spend inside vehicles will increase. Automotive fabric manufacturers are also expected to contribute to creating a home or office comfort experience within the vehicle through fabric designs. In order to enhance this experience, the quilted fabric structures commonly found in home upholstery have been investigated. Pocket structures supported by filler yarns are frequently observed in matelassé fabrics. In the scope of this study, fabrics supported with filler yarns in three different pocket sizes were produced. Produced fabrics were evaluated for surface abrasion, horizontal combustion, and seam fatigue tests according to the specifications of a major automotive manufacturer. Based on the test results, the effect of the sizes of these structures on automotive fabric quality was investigated.

Keywords: Automotive seat fabric, autonomous vehicles, matelassé fabric, weaving, pocket structures on weaving

INTRODUCTION

Automotive upholstery fabrics are composite structures consisting of surface fabrics, polyurethane laminated foam, and scrim layers, where flame lamination is used to combine these layers. The face fabric structures are produced to provide essential technical and aesthetic characteristics. In the production of these surfaces, PET-based air or friction-texturized yarns that meet automotive standards such as high abrasion resistance, flame resistance, and high lightfastness are commonly used [1]. Weaving machines with dobby or jacquard weaving techniques are generally used in fabric production, with pattern repeats such as double rips, panama, and twill. Although initially most of the automotive fabrics are jacquard woven structures producing using plain, dobby, or small-scale designs, trends and demands tend to move beyond traditional automotive patterns. Automotive companies or OEMs employ qualified textile designers to create designs and colors [2].

In the upcoming years, it is predicted that autonomous vehicle technology will increasingly dominate the automotive industry. Autonomous vehicles, equipped with automatic control systems, are capable of navigating, perceiving the road, traffic flow, and surroundings without the need for a driver's intervention [3]. As a result, it is anticipated that users of autonomous

vehicles will be able to utilize their time during traffic by reading books or coordinating their work in the car. Consequently, the time spent by driver or occupent inside vehicles is expected to increase. Considering that 1/4 of the human body comes into contact with the seat, there is a need for designs in autonomous vehicles that create a home or office atmosphere. It is inevitable to improve the aesthetic and comfort properties of seat fabrics to achieve this atmosphere [3,4]

To create a home atmosphere in the vehicle, fabric structures used in home upholstery and bedding surfaces have been investigated for utilization of automotive seat cover fabrics. When examining these fabrics, it is observed that the structural characteristics or application processes mimic the irregular properties of natural textures. These fabrics, referred to three-dimensional, relief, or voluminous fabrics, achieve effects such as puffed, porous, or indented through the combination of structure and material. Matelassé fabrics, where the pocket or quilt effect is given to highlight the patterns, are among the most prominent representatives of relief fabrics. Matelassé fabrics are categorized as double-layer voluminous fabrics, and the use of filler yarns in the double-layer areas creates a quilted effect on the fabric [5]. It is known that these structures have a positive effect on thermal comfort [6]. In this study, inspired by matelassé fabric structures, double-layer fabrics supported with filler yarns in three different pocket sizes were produced. The produced fabrics were evaluated for surface abrasion, horizontal combustion, and seam fatigue tests according to the specifications of a major automotive manufacturer. The impact of pocket sizes on the test results was investigated.

EXPERIMENTAL STUDY

Materials

In this study, double-layered automotive seat fabrics produced by filler yarn supported pocket structures, which contribute to the creation of home or office comfort with automotive seat fabrics, were used. The fabrics were produced on a double-beam, 66 warp density. 100% PES 150 Denier, 450 Denier, and 1200 Denier filler yarns were used in the weaving process. 30 dens 4.1 mm PU-based lamination foam and 40 gr/m2 PA-based scrim layer, produced by Martur Automotive Seating Systems, were laminated on the back of the fabric. Each fabric was treated in 70 degree open width washing and stentering processes under the same conditions.

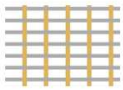
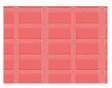
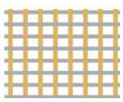
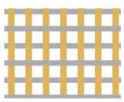
Design	Warp Densty	Weft Densty	Warp Yarn	Weft Yarn	Number of Warp ends per cm	The Length of the Pocket Structure (cm)	Pattern Simulation	Pattern Report
Design 1	66	48	LIGHT BLUE 150 Denier %100 PES	Grey 150 Denier %100 PES	94	1,4		
				BLACK 450 Denier %100 PES				
			DARK BLUE 450 Denier %100 PES	BLACK 1200 Denier %100 PES (Filler Yarn)				
Design 2	66	48	LIGHT BLUE 150 Denier %100 PES	Grey 150 Denier %100 PES	56	0,84		
				BLACK 450 Denier %100 PES				
			DARK BLUE 450 Denier %100 PES	BLACK 1200 Denier %100 PES (Filler Yarn)				
Design 3	66	48	LIGHT BLUE 150 Denier %100 PES	Grey 150 Denier %100 PES	41	0,62		
				BLACK 450 Denier %100 PES				
			DARK BLUE 450 Denier %100 PES	BLACK 1200 Denier %100 PES (Filler Yarn)				

Figure 1. Weaving Parameters of Produced Woven Fabrics

Method

Surface Abrasion Test

Surface abrasion is the deformation that occurs as a result of the rubbing of one surface against another. During the time spent in a vehicle, upholstery fabrics are subjected to the friction caused by different materials worn by utilizers, making surface abrasion tests crucial for automotive upholstery. The test is performed by rubbing the abrasion fabric on the fabric surface for 10.000 cycles under 1kg weight.

Figure 2. Surface Abrasion Test Machine

Flammability Test

The self-ignition rate of the test fabric is calculated in mm/min after it is ignited at predetermined intervals inside a special chamber. This is one of the tests that every automotive manufacturer emphasizes on. It is desired to have the shortest possible time for the flame initiated on the sample to reach a specified point inside the combustion chamber. Flammability tester is indicated in Figure 3.

Figure 3. Combustion Chamber

Seam Fatique Test

Seam strength is the resistance of the stitch to tearing when a force is applied perpendicular to the direction of the stitch on sewn fabrics. It is essential for the stitch to be made using the actual needle and thread. Seam strength is measured by applying it to samples cut in the lengthwise, crosswise, bias, and reverse bias directions. Seam fatique test was performed according to 400 cycles.

Figure 4. Seam Fatique Test Machine

RESULTS AND DISCUSSION

Surface Abrasion Test Results

The surface abrasion resistance tests is performed separately on the produced fabrics. It is observed that the surface abrasion resistances of each fabrics produced using different pocket dimensions are similar. A major difference was not seen from the comparison of pocket structures. It has been observed that the 1st fabric, which has the largest pocket structure, has a little more fluff compared to the 2nd and 3rd fabric. However according to the surface abrasion test results, it has been observed that the pocket structure in all three fabrics meets the automotive standards. Evaluation was made according to the gray scale.

Table 1. Surface Abrasion Test Results

	Surface Abrasion 1kg, 10.000 cycles (TSL 2105G (4.7.3))
Design 1	4
Design 2	4
Design 3	4

Flammability Test Results

In the flammability test each fabric were performed in the width direction. Each fabrics results were 70-71 mm/min in the flammability test. It is observed that pocket structures content fabrics show similar flammability behaviour.

Table 2. Flammability Test Results

	Flammability (TSM 0500G) (mm/min)
Design 1	70
Design 2	71
Design 3	70

Seam Fatique Test Results

It was observed that the increase in pocket structures did not adversely effect the sewing fatigue test result.

Table 3. Seam Fatique Test Results

	FATIGUE OF SEAMS 400 CYCLES (D45 2024) (mm)
Design 1	1,0
Design 2	1,5
Design 3	1,0

CONCLUSION

In this study, inspired by matelassé fabric structures, three different pocket size of double-layered woven fabric supported with filler yarns were produced. In order to evaluate the adaptability of these structures to automotive, their performance in automotive standards was examined. Although it is thought that the increase in pocket length will negatively affect the combustion speed by creating an air gap, it has been observed that the difference of 0,78 cm does not affect the test result. It was also observed that there was no effect on seam fatigue and surface wear tests. When the test results were evaluated, it was observed that the pocket size would be between 0.62 cm - 1.4 cm, it would be suitable for use in automotive standard and it could be an alternative to traditional automotive fabrics.

REFERENCES

[1] AKKUŞ, İ. (2019). Otomotiv döşemelik kumaş tasarımı ve tasarımı belirleyen faktörlerin incelenmesi (Yüksek lisans tezi). Eskişehir Teknik Üniversitesi, Endüstriyel Sanatlar Anabilim Dalı, Eskişehir.
[2] HARDCASTLE, J.M.,9 - Woven textiles for automotive interiors and other transportation applications,In The Textile Institute Book Series,Woven Textiles (Second Edition),Woodhead Publishing,2020,Pages 395-422,ISBN 9780081024973, https://doi.org/10.1016/B978-0-08-102497-3.00009-X.
[3] ÖZCAN BERBER, R., KURT, R., TUNA, T., TURAN, S.,KORKMAZ, V.,BEKTAŞ, E. Otonom araçlarda müşteri beklentileri ve konsept koltuk tasarımı. 9th International Automotive Technologies Congress OTEKON, 7-8 May 2018, BURSA
[4] ÇEKEN, F., & PAMUK, G., (2006). Properties of automotive seat fabrics. Technische Textilien , vol.49, no.1.
[5] BAŞARAN, F. N., & ÖZCAN, N., (2020). "Matelasse" Kumaşlar ve Özellikleri. RESEARCHER SOCIAL SCIENCE STUDIES , vol.8, no.2, 81-98.
[6] ABBASI, S.A., MARMARALI, A., & ERTEKİN, G. (2020). Thermal comfort properties of weft knitted quilted fabrics. International Journal of Clothing Science and Technology.

REVOLUTIONIZING SEWING MACHINES: ANALYZING THE INTEGRATION OF BOBBIN THREAD DETECTION DEVICES

İsmail İvedi[1], Şenol Yılmaz[2], Bahadır Güneşoğlu[2], Seda Çeker[2]
[1,2] Roteks Tekstil İhr. San. ve Tic. A.Ş. / R&D Department / AOSB, Çiğli, İzmir
ismailivedi@roteks.com.tr

ABSTRACT

Considering that the production of ready-to-wear is a labor-intensive sector, efficiency is crucial. In mass production, similar operations are done repeatedly, and it is not desirable to waste time with divisive works. One of the reasons that interrupt the sewing machine operator's work and cause wasted time is running out of thread on the bobbin. Since the bobbin is in the bobbin case located under the sewing machine table, it cannot be seen, and the remaining thread amount cannot be checked. This research is expected as a technological advance for an automated, unmanned sewing process that measures the amount of thread still in the bobbin.
In this study, a system that measures the remaining thread amount is provided by an electrical signal with the help of a pin that enters the bobbin when the sewing process for detecting the remaining thread on the lower bobbin is completed and the thread wiper breaks the thread and warns the operator when it reaches the predetermined amount has been integrated into the sewing machines. Therefore, it is aimed to increase productivity by reducing time loss and to increase the quality of sewing, since no joints will be made in the seams. The lower bobbin measuring system integrated into the lockstitch sewing machine and compared with the conventional method, it is seen that the system that measures the lower bobbin thread amount reaches the breakeven point in nine months.

Key Words: Sewing, bobbin thread, denim, automation

INTRODUCTION

The future of the global textile and clothing (T&C) industry is a key topic of discussion. This fourth industrial revolution is a paradigm shift that has the potential to create the "smart factory" of the future by fusing the real and digital worlds [1].
The sewing process is one of the most time-consuming process in the manufacturing process of textile products. Due to the recent rise in labor costs, sewing costs are gradually rising. Along with the 4th industrial revolution, automation of the sewing process and smart factories are expected. Applying intelligent sensor technology to the sewing machine is essential to make the garment factory intelligent [2].

Due to the wide range of styles and fabric options available for the products, apparel manufacturing has always been labor demanding. To conduct consistent operations over a wide range of styles, most sewing machine manufacturers and several larger apparel firms have created semi-automated sewing stations. Since it affects the price of producing and distributing textile products, predicting sewing thread consumption demands an accurate computation approach. Researchers in the past have called attention to issues with the formulas used to calculate the amount of thread needed for sewing activities, including their restrictions. Due to a lack of knowledge about crucial factors that affect thread consumption, the current methods of consumption calculations display high error rates [3].

One of the important considerations in the purchase of thread is the prediction of sewing thread consumption.

For their logistics and purchasing operations for thread, both garment makers and thread suppliers in the apparel sector forecast the amount of thread that will be used per unit length of the stitch. For both clothing manufacturers and sewing thread makers, erroneous thread consumption projections result in inaccurate costs and lower warehouse utilization [4].

Time losses related to the bobbin in mass production can be classified as follows.

1. Personnel notice the thread end of the lower bobbin during operation and when sewing is not performed.
    a. Since re-joining the sewing place is unsuitable in terms of quality, dismantling is done.
    b. and the operation starts from the beginning.
2. The operator continues to sew without noticing that the lower bobbin has run out of thread, and more than one job (piece) is progressing without sewing.
    a. When this is noticed, how many pieces are detected and moved in the opposite direction of the belt flow.
    b. Since no additional stitching can be done, the dismantling process takes place.
    c. The same operations are repeated.
    d. There may be a meta confusion.
3. When the lower bobbin runs out, if there is no threaded bobbin in reserve, time is wasted in winding the bobbin.

In this study, a system includes, a lower thread detection device for detecting a lower thread wound around a bobbin each time a sewing machine stops driving, comprising: a detection pin extending from the outer periphery toward the center in the radial direction of the bobbin; A moving means for moving the bobbin toward a center of the bobbin, a contact switch for detecting movement of the detecting pin, and a position adjusting knob for adjusting the position by screw feeding the contact switch in the moving direction of the detecting pin lower thread detecting device that measures the remaining thread amount with an electrical signal and warns the operator when it reaches the predetermined amount [5], with the help of a pin inserted into the bobbin, is integrated into the sewing machines while the sewing process for the detection of the remaining thread on the lower bobbin is completed and the thread wiper breaks the thread [6]. Thus, it is aimed to increase productivity by reducing time loss and to increase the quality of sewing, since no joints will be made in the seams.

EXPERIMENTAL

There are numerous distinct types of seaming have been devised for various sewing applications [7]. Due to the intense use of denim and non-denim sewing operations, the DDL-8700 model lockstitch sewing machine was selected for the integration of the bobbin thread detection device from Juki, Japan. Bobbin thread detection device was supplied by Shiro International Co., Japan. 60 tex polyester for the lower bobbin and 105 tex polyester for stitching threads were supplied from Coats, UK. Indigo-dyed denim fabric was purchased from Matesa Denim AŞ., Turkey. The weight of the fabric is 12 oz/yd^2. It has a 3/1 Z twill weave structure, and 98/2% - CO/EL fabric composition.

In order for the measuring pin to measure the remaining thread amount, a hole is drilled into the bobbin case so that the pin can enter (Figure 1).

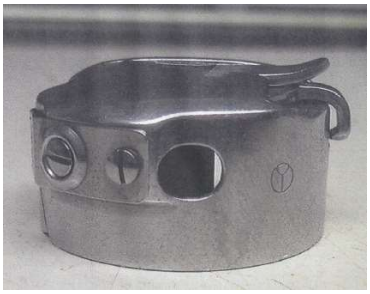


Figure 1. A hole was drilled in the bobbin case

The bobbin checker functions by an electric circuit and an air electromagnetic valve. The measurement pin was powered by DC24V from the sewing machine. The pressure of the air valve was set to 0.3 MPa. Electrical wires from the bobbin checker were connected to the control box of the sewing machine. The measuring pin was inserted into the inside of the hook/bobbin case and physically detects the remaining amount of bobbin thread. The determined amount of remaining bobbin thread on the bobbin is adjustable to specific requirements by adjusting the position of the limit switch. Figure 2 shows the image of the bobbin thread detection system assembled on the sewing machine.

Figure 2. Bobbin thread detection system

Denim fabrics were cut according to the determined design. Then, the assembly processes of the fabrics were carried out on the lockstitch sewing machine according to 301 stitch types. The processing times of the fabrics repeatedly sewn on the sewing machine with the lower bobbin thread warning system and the standard lockstitch sewing machine were compared. Table 1 includes the experiment plan.

Table 1. Experimental plan

Code	Operation	Stitch type	Number of needles	Number of stitched fabrics
M1	Bottom hem sewing	301	2	483
M2	Bottom hem sewing	301	1	404
M3	Bottom hem sewing	301	1	157

RESULTS AND DISCUSSION

Table 2 shows the time study results of repeated sewing operations with the selected models.

Table 2. Process time difference study results

Code	Operation	Bobbin Change Times (sec)	Total seam removal time (sec)	Number of stitched fabrics
M1	Bottom hem sewing (2-needle)	740,76	4108,06	483
M2	Bottom hem sewing	332	753,5	404
M3	Bottom hem sewing	289,2	25,8	17

The average dismantling time for each product of the samples sewn on the sewing machines without the lower bobbin warning system was calculated according to formula 1.

$$ad = \frac{a/b}{60} \qquad \text{ad= ((a/b))/60} \qquad 1$$

Where,

a is the total seam removal time,

b is the number of stitched fabrics and,

ad is the average dismantling time.

The daily labor loss of a company that produces an average of 2000 products per day is calculated according to formula 2.

$$l = \frac{(ad*2000)}{540} \qquad \text{l= ((ad*2000))/540} \qquad 2$$

Where,

l is labor loss

When calculations are made according to formulas 1 and 2 for the trials with code numbers M1, M2, and M3, the results in Table 3 are obtained.

Table 3. Lost labor results for samples

Code	Average dismantling time per sample (min)	Labor loss (daily)
M1	0,14	0,52
M2	0,031	0,11
M3	0,025	0,09

When the results were examined, no significant difference was observed between the M2 and M3 trials. However, when the average dismantling time per sample and daily labor loss results of trial number M1 were compared with other trials, a significant difference was observed. Since trial number M1 is a twin-needle machine, there are two bobbins. The reason for the 78% higher labor loss compared to other trials was attributed to this situation.

CONCLUSION

The fourth industrial revolution is anticipated to bring about the automation of the sewing process and the smart factory. Applying smart sensing technology to the sewing machines is crucial for making the sewing factories intelligent.

In this study, the conventional lockstitch sewing machine has been modified and a system integration has been made that warns the personnel about the thread remaining on the lower bobbin is close to running out. The advantage of the modified machine over the conventional method was determined by the labor force and dismantling time. The developed system provided a 78% advantage over the conventional method in terms of labor. The Textile & Clothing industry should stop being a labor-intensive industry in the increasingly widespread industry 4.0 era and adapt to digitalization with such minimal integrations.

REFERENCES

[1] LUU, HA; FERREIRA, FERNANDO; MARQUEX, ANTÓNIO DINIS. Digitisation and Industry 4.0 in the Portuguese T&C sector. 2019.

[2] LEE, JAE-YONG, ET AL. Study on sensing and monitoring of sewing machine for textile stream smart manufacturing innovation. In: 2017 24th International Conference on Mechatronics and Machine Vision in Practice (M2VIP). IEEE, 2017. p. 1-3.

[3] ABEYSOORIYA, R. P., & WICKRAMASINGHE, G. L. D. Regression model to predict thread consumption incorporating thread-tension constraint: study on lock-stitch 301 and chain-stitch 401. *Fashion and Textiles*, 2014, *1*(1), 14.

[4] SAMUEL WESLEY, D. POOJITHA, V. A simple system for the online detection of skip/loop stitches in single needle lockstitch sewing machines. AUTEX Research Journal, 2010, 10: 69-72.

[5] KINOSHITA, H. MASAHITO, H. Sanki Engineering Co Ltd., Sewing machine bobbin thread detecting device. JPH0924176A, 1997.01.28.

[6] KINOSHITA, H. RYUZO, S. TADASHI, K. KINOSHITA SEIMITSU KOGYO KK. Bobbin thread detecting device. JP2017035127A, 2017.08.03.

[7] ISO 4915:1991, Textiles - Types de points – Classification et terminologie

THE USE OF RECYCLED COTTON FIBERS FOR SUSTAINABLE TEXTILE PRODUCTION

Aslıhan Kabas[1], Huseyin Kadoglu[2] , Tuba Bedez Üte[3]
[1] Ege University / Graduate School of Natural and Applied Sciences / Izmir -Türkiye
[2] Ege University / Engineering Faculty Textile Engineering Department / Izmir-Türkiye
[3] Ege University / Engineering Faculty Textile Engineering Department / Izmir-Türkiye
aslikabaass@gmail.com

INTRODUCTION

Due to the depletion of natural resources and global warming, the sustainable recycling of textile waste has become an important issue worldwide. However, reuse and recycling of consumed products is still at very low levels. A large volume of pre-consumer cotton textile wastes such as cutting scraps, ball heads or damaged fabrics are released during textile production in the industry. In the present study, we transform pre-consumer textile waste into fibers and examine the properties of yarns produced using various mixtures of recycled fiber with natural color cotton fiber, raw cotton fiber and viscose fiber. We report results on breaking strength, breaking elongation and uster evenness tests. The present work is an important contribution for the production of high quality sustainable recycled fabrics in the future.

LITERATURE REVIEW

Sustainability is of great importance for the producer and the final consumer in the textile industry[1]. There are four main approaches to sustainable textile production which are summarized below:

1. Substitution of Fibers: Synthetic fibers from renewable resources are seen as more sustainable alternatives in the future to replace natural fibres. For example, cellulose-based Lyocell and Qmilch fibers from milk protein are considered alternatives from renewable resources[2].
2. Integrated Production of Natural Fibers: The integrated production system works on reducing environmental impacts by using less pesticides, fungicides, chemical fertilizers and water. Certification systems such as "Cotton made in Africa" and initiatives such as the "Better Cotton Initiative" provide examples of this approach[3].
3. Organic Fibers: Organic cotton production aims to produce cotton through a material flow that is compatible with the natural environment. Chemical fertilizers, drugs and genetically modified organisms are not used[3].
4. Using Recycled Fibers: Recycling cotton is still underutilized by textile and apparel manufacturers and retailers. While polyester is the most widely used material in recycling applications, recycling cotton is still a new topic[4].

The present work explores this approach.

MATERIAL AND METHOD

In this research, recycled cotton fiber is blended with other fibers in five ratios (%50-50, %60-40, %70-30, %80-20, %90-10). Three different yarn counts are obtained from blended fibers (Ne16, Ne20, Ne24). The yarns obtained are subjected to some tests: tensile strength and elongation, Uster evnness test and yarn count test. As a result of all these studies, 30 cm knitted fabrics were produced from Ne20 number yarns for visual evaluations.

CONCLUSION AND DISCUSSION

Thanks to the data we obtained from the statistical evaluation in all mixing ratios, the following inferences were made:

1. When the breaking strength values are examined: Using yarn count Ne24, raw cotton/recycled cotton as raw material, 90/10 as a blending ratio for double blends and 40/40/20 for triple blends produced the highest breaking strength.
2. When the elongation at break values are examined: Using yarn count Ne20, viscose/recycled cotton as raw material, 90/10 as a blending ratio in double blends and 40/40/20 as a blending ratio in triple blends produced the highest elongation at break.
3. When the irregularity (%CV) values are examined: Using yarn count Ne20, raw cotton/natural colored cotton/recycled cotton as a raw material, 30/30/40 as a blending ratio and 50/50 (viscose/recycled cotton) as a blending ratio for binary blends produced the highest unevenness.
4. When the hairiness (H) values are examined: Yarn count Ne16, as raw (virgin) cotton/natural colored cotton/recycled cotton, as a blending ratio of 30/30/40 and in binary blends as a blending ratio of 50/50 (raw (virgin) cotton/recycled cotton) out produced the highest hairiness.

While yarn count, raw material variety and raw material ratio do not affect each other, i.e., they do not show any interaction effects in terms of breaking strength, elongation at break and hairiness; yarn count and raw material variety show an interaction when examining unevenness.

Keywords: Sustainability, Natural colored cotton, Recycled cotton.

REFERENCES

[1] MANGIR, A.F. Fast and Slow Fashion For Sustainable Development. Journal of Selcuk University Vocational School of Social Sciences, 2016, Volume:19, 41st Anniversary Special Issue pp.143-154, Article Submission Date: 05/11//2016 – Acceptance Date: 20/12/2016.

[2] SHISHOO, R. The use of renewable resource based materials for technical textiles applications, Ecotextiles: The Way Forward for Sustainable Development in Textiles, Miraftab, M. and Horrocks, A.R. (Eds), Woodhead Publishing, 109-127, Cambridge, 2007. s. 208p.

[3] HANSEN, E.G. and SCHALTEGGER S. 100 Per Cent organic? A sustainable entrepreneurship perspective on the diffusion of organic clothing. Emerald Group Publishing Limited, ISSN 1472-0701,VOL. 13 NO. 5 2013, pp. 583-598,Corporate, 2013. s. 583-598.

[4] WANG, Y. Recycling in Textiles, Woodhead Publishing Ltd. Cambridge, UK., 2006. s. 248p.

INVESTIGATION OF BLEACHING AND DYEABILITY OF KNITTED FABRICS BY FOAM APPLICATION METHOD

Seda Keskin[1], Onur Balcı[2], Koray Pektaş[2], Durul Büşra Dilden[1]
[1] Eren Retail & Textile Inc R&D Center, 59930 Ergene, Tekirdağ, Turkey
[2] Kahramanmaraş Sütçü Imam University / Textile Engineering Department / Avşar Campus, 46100, Onikişubat,Kahramanmaraş,Turkey
seda.keskin@erenperakende.com

INTRODUCTION

Day by day, our sensitivity to the environment is increasing with the increase in social awareness. accordingly, not only as consumers but also as producers, we are oriented towards more environmentally friendly products in almost every field. When we consider textile wet treatment processes, it is one of the most environmentally damaging industries. Therefore, more environmentally friendly approaches are gaining importance in the textile industry day by day. Briefly, when we examine the conventionally used wet processing processes, we come across impregnation and exhaust methods. these methods, which are very widely used, use a large amount of water, chemicals, and energy, while leaving a large amount of wastewater to the environment. When we examine the methods that will be an alternative to these methods and that may be more sensitive to the environment, we come across the foam application method [1]–[3]. In order to make more environmentally friendly applications in the textile industry, the bleaching and dyeing processes were carried out with the foam application method within the scope of the study. The effects of the concentrations of the chemicals used in the bleaching processes and the % pick-up values on the bleaching process were examined. In order to make a comparison, the bleaching and dyeing processes were carried out with conventional impregnation and exhaustion methods as well as foam application method. When the data obtained accordingly were examined, it was seen that the desired Berger whiteness index values could be achieved with the foam application method. As for the foam dyeing, the dyeing process carried out successfully and it was seen that it can be used as an alternative method to the conventional dyeing processes.

MATERIAL AND METHOD

Material

The raw and bleached Ne 30/1 suprem knit fabric was used in the study.
In the study, peroxide, NaoH, wetting agent, sequesting agent, foaming agent and stabilizer was used in the foam bleaching process, while Setazol Golden Yellow NG Conz, Setazol Navy WRG Conz, Setazol Red NG Conz, NaOH, soda and foaming agent were used in the foam dyeing process.

Method

The bleaching and dyeing recipes for the foam application methods are given in Table 1.

Table 1. Bleaching and dyeing recipe

Bleaching Recipe		Dyeing Recipe	
Chemical	**Concentration (g/L)**	**Chemical**	**Concentration (g/L)**
NaOH	70	Setazol Golden Yellow NG conz	2.25
Peroxide	70	Setazol Navy WRG conz	16.5
Wetting agent	2	Setazol Red NG conz	8
Sequesting agent	1	NaOH	25
Foaming agent	50	Soda	100
Stabilizer	4	Foaming agent	30
		Wetting agent	2

The foam formation for both bleaching and dyeing was achieved by mixing with a mixer at 3000 rpm. The blow ratio of the foam obtained was measured as 1/8. The foams obtained in the foam application method were transferred onto the fabric using a laboratory type coating machine. The foam was transferred onto the fabric via knife over air coating method and the coating thickness was adjusted as 0.05mm. After the foam application, the fabrics were steamed with saturated steam at 102 °C for 5 minutes. After that the fabric washed in five steps and dried at 120 °C for 4 minutes on laboratory stenter.

Test and Analyses

Within the scope of the study, bursting strength, pilling, abrasion resistance, Berger whiteness measurement, colour measurement and hydrophilicity tests for bleached fabrics, the color fastness to washing, water and sweat tests were carried out for dyed samples.

RESULT

The Berger value of the fabrics was measured after bleaching with foam application. When the data obtained were analyzed, it was determined that the Berger value of the fabrics was >55 with the foam application method. The color obtained from the dyeing recipe according to the exhaustion method was accepted as the reference color within the scope of the study, and the fabrics dyed according to the foam application method was compared with the reference one. When the color measurement values obtained are examined (Table 2), it is thought that there is a color difference between the reference sample and the color of foam dyed sample, but this color difference will be eliminated by optimizing of the recipe.The most important issue is dyeability of the cotton samples by foam application.

Table 2. Color measurement of the fabric

	CIELab Values			Color Difference Values			
Sample	**L***	**a***	**b***	**ΔL***	**Δa***	**Δb***	**ΔE***
Reference Fabric	21.14029	1.385604	-12.35986	-	-	-	-
Foamed Dyed Fabric	24.70578	0.136062	-13.99625	3.56549	-1.249542	1,63639	4.117

CONCLUSION

In the study, the bleaching and dyeing processes were carried out by foam application method, which is an alternative method to conventional wet processes. The data obtained from foam

applications were compared with conventional methods. Accordingly, it was determined that bleaching and dyeing can be performed with foam application method. In addition, it is thought that water and energy consumption and waste water load can be significantly reduced by spreading of this method in the textile industry.

Keywords: Foam bleaching, foam dyeing, knitted fabric, cotton, textile

REFERENCES

[1] BASYIGIT, Z. O., KUT, D. AND HAUSER, P. "Development of multifunctional cotton fabric via chemical foam application method," Text. Res. J., vol. 90, no. 9–10, pp. 991–1001, 2020.
[2] SHANG, S., HU, E., POON, P., JIANG, S., KAN, C. W. and KOO, R. "Foam Dyeing for Developing the Wash-out Effect on Cotton Knitted Fabrics with Pigment," Res. J. Text. Appar., vol. 15, no. 1, pp. 44–51, 2011.
[3] M. MOHSIN et al., "Performance enhancement of water and energy efficient foam dyeing and finishing through different foaming agents," J. Nat. Fibers, vol. 20, no. 1, 2023.

INVESTIGATION OF UV RESISTANCE PROPERTIES OF BICOMPONENT YARNS PRODUCED WITH DIFFERENT ADDITIVES

Kerim Kılınç[1,3], **Hüsnü Kemal Gürakın**[2], **Eda Çorapçı**[1,3], **Ahmet Turan**[2]
[1] *Polyteks Tekstil Sanayi Araştırma ve Eğitim AŞ / R&D Center / Bursa, Türkiye*
[2] *SETAŞ Kimya Sanayi AŞ / Color Center / Tekirdağ, Türkiye*
[3]*Bursa Uludağ University / Graduate School of Natural and Applied Sciences / Bursa, Türkiye*
kkilinc@tasdelengroup.com

Polyethylene terephthalate (PET) is the most widely used chemical fiber in the world [1]. PET fibers represent more than 50% of the world's synthetic fiber production because of their properties such as high tenacity, moderate elongation, processability, chemical resistance and thermal stability [2-4]. However, they have some inherent negative properties such as high pilling tendency, lower UV resistance and relatively low abrasion resistance [5]. Special additives can be added in the PET raw material to improve the existing properties as well as obtain new functional properties [6]. It could be preferable to use bi-component machines rather than conventional machines to produce any functional yarns. UV radiation causes the breaking of chemical bonds in polymeric structures and this degradation is called photodegradation [7,8]. Special additives with UV absorption features are used to protect the polymer from the harmful effects of UV radiation and to prevent degradation after exposure to sunlight [9].

In this study, the first step was to produce bi-component fibers at the same denier and parameters by using 24 holes core/sheat cross-section spinnerets. Super bright PET raw materials were used for both the core side and the sheat side. In addition, two different dosages of titanium dioxide were added in the core side and two different dosages of triazin based UV absorber were added in the sheat side. The yarns produced were classified in two headings based on titanium dioxide (TiO_2) and UV absorber (Table 1 and 2). Standard textile analyzes such as elongation at break, tenacity, dtex, unevenness, shrinkage and cross-section were applied to 5 different yarns produced with different additive combinations. Also, differential scanning calorimetry (DSC) analysis was performed on all samples to determine thermal and morphological properties. The second step was to apply UV weathering tests to all fibers according to ISO 105-B04 standard. Elongation at break and tenacity measurements were made to each yarns after 500 hours and 1000 hours to calculate the decrease in physical strength. It was observed that the tenacity of all bi-component yarns decreased by approximately 70% after 500 hours. While the tenacity of the yarns containing 1,2% titanium dioxide couldn't be measured after 1000 hours of UV weathering test due to their significant decrease, the yarns containing 2% UV absorber maintained the tenacity of 21% after 1000 hours of UV weathering test (Figure 1). The effects of the UV absorber additive on the thermal and morphological properties couldn't be determined in the DSC analysis. However, it was concluded that TiO_2 additive increased the melting temperature and decreased the melting enthalpy of samples.

Table 1. The samples according to the UV absorber ratio of sheat side in the yarns

Sample Number	Core	Sheat
Sample 1	Bright PET + %1,2 TiO_2	Bright PET
Sample 2	Bright PET + %1,2 TiO_2	Bright PET + %2 UV Absorber
Sample 3	Bright PET + %1,2 TiO_2	Bright PET + %4 UV Absorber

Table 2. The samples according to TiO_2 ratio of core side in the yarns

Sample Number	Core	Sheat
Sample 4	Bright PET	Bright PET + %2 UV Absorber
Sample 5	Bright PET + %0,3 TiO_2	Bright PET + %2 UV Absorber
Sample 2	Bright PET + %1,2 TiO_2	Bright PET + %2 UV Absorber

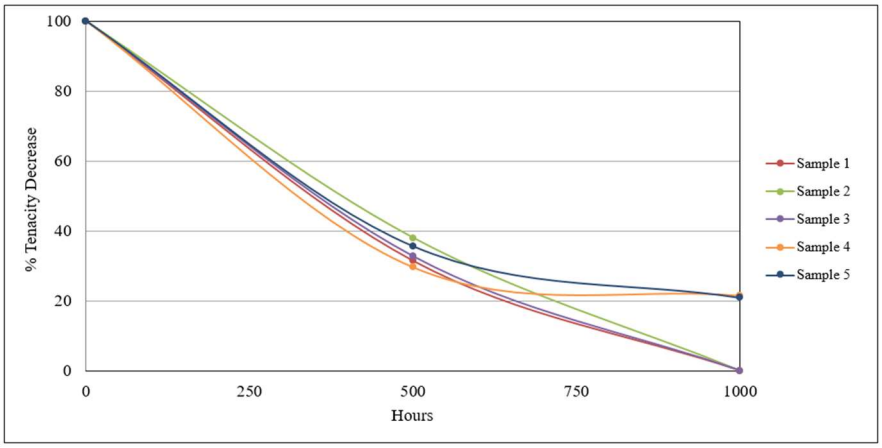


Figure 1. The tenacity decrease of the all samples after weathering tests

Keywords: Bi-component yarns, Core/Sheat, UV resistance, UV weathering test, Tenacity

[1] INCORNATO, L., SCARFATO, P., DI MAIO, L., ACIERNO, D. Structure and rheology of recycled PET modified by reactive extrusion. Polymer, 2000, vol. 41, pp 6825–6831.
[2] SCHEIRS, J. Modern Polyesters: Chemistry and Technology of Polyesters and Copolyesters, Wiley Series in Polymer Science. John Wiley & Sons, Sussex, England. 2003.
[3] SEVENTEKİN, N. Kimyasal Lifler. Ege Üniversitesi Tekstil ve Konfeksiyon Araştırma-Uygulama Merkezi Yayını, İzmir, 2003, pp 52-69.
[4] PAWLAK, A., PLUTA, M., MORAWIEC, J., GALESKI, A., PRACELLA, M. Characterization of scrap poly (ethylene terephthalate). European Polymer Journal, 2000, vol. 36, no. 9, pp 1875–1884.
[5] KOÇ, S.K., HOCKENBERGER, A.Ş. Investigation of Air-Jet Texturing Of Technical Polyester Yarns. Tekstil ve Konfeksiyon, 2010, vol. 4, pp 299-305.
[6] SINHA, V., PATEL, M.R., PATEL, J.V. Pet Waste Management by Chemical Recycling: A Review. Journal of Polymers and the Environment, 2008, vol.18, no.1, pp 8–25.
[7] UV/Light Stabilizers for Adhesives [online], updated 01.06.2012. [cited 17.05.20239]. Available on https://adhesives.specialchem.com/selection-guide/uv-light-stabilizers-state-of-the-art/ultraviolet-absorbers
[8] BREESE, R.R. General Effects of Aging on Textiles. Journal of American Institute for Conversation, 1986, vol. 25, pp 39-48.
[9] GERLOCK, J.L., BAUER, D.R., BRIGGS, L.M., DICKIE, R.A. A Rapid Method of Predicting Coating Durability Using Electron Spin Resonance. Journal of Coating Technology, 1958, vol. 57, pp 37–46.

PASSIVE SMART CELLULOSIC KNITTED FABRICS WITH ENHANCED PERMEABILITY AND ABSORPTION FEATURES

Nazife Korkmaz Memiş[1], Sibel Kaplan[1], Mehmet Kertmen[2]
[1] *Süleyman Demirel University / Textile Engineering Dept. / Isparta/Türkiye*
[2] *Iskur R&D Center/Kahramanmaraş/Türkiye*
mehmet.kertmen@iskur.com

INTRODUCTION AND AIM

Consumer expectations have changed in recent years in the direction of 'maintaining comfort in all conditions', a situation supported by the increasing market shares of sports and leisure clothing [1]. The next stage of the comfort studies especially for functional sports and protective clothing is to provide comfort dynamically according to the changes in environment and body conditions, other than the classical approach aiming to keep body dry and warm/cool under static conditions. In this context, shape memory polymers/nanocomposites [2] enabling a change in shape, porosity, etc. of the material adaptively depending on the environment and body conditions attract attention. For developing smart textile materials having dynamic clothing comfort; knitted cotton and regenerated cellulosic fabrics for sports and leisure wear were treated with temperature-water sensitive shape memory nanocomposite for dynamic breathability and absorption functions by keeping the acceptable fabric hand features.

MATERIAL AND METHODS

Single jersey knitted fabrics were produced with cotton, regenerated cotton, viscose, modal, lyocell, and bamboo Ne 30/1 ring spun yarns on a Pilotelli Circular Knitting Machine. Cellulosic knitted fabrics were treated with shape memory nanocomposites for optimum temperature-water sensitive dynamic functions at acceptable fabric bending rigidity limits. The shape memory nanocomposites were produced with commercial SMPU polymer matrix, having appropriate T_{trans} temperature of 32°C, suitable for body temperature, and CNWs as water responsive nano-reinforcing switch. To prepare nanocomposite suspensions, SMPU polymer was dissolved in dimethyl acetamide, an eco-friendly solvent, at 8wt% concentration according to preliminary studies (for optimizing bending rigidity). The polymer solution was mixed with CNW-dimethyl acetamide-surfactant suspension having nanoparticle concentration, 20 wt% of polymer by ultrasonic stirring (SMPU-CNW20). The cellulosic knitted fabrics were treated with the produced nanocomposite solutions by a pad-dry-cure process (drying at 90°C for 5 min and curing at 120°C for 5 min). Surface morphologies, elemental content, and chemical structure/fabric-nanocomposite interactions of the fabrics were detected by SEM, SEM-EDX, and FT-IR analysis, respectively. Weight and bending rigidity tests were carried out according to TS EN 12127 and ASTM D 1388-92:2002 for determining effect of the nanocomposite treatment. Shape memory based dynamic air permeability of the fabric was measured according to TS 391 EN ISO 9237 at different fabric temperatures (20°C and 40°C) using the Textest FX 3300 Air Permeability Tester. Fabric temperature of 40°C was adjusted by a hotplate having a set function and determined with a thermal camera (Fluke Ti100). Dynamic absorption capacity tests were conducted with different water temperatures (20°C and 40°C) according to AATCC TM 199 to determine the changes in liquid absorption capacities with temperature and water responsiveness.

RESULTS AND DISCUSSION

According to SEM, SEM-EDX results, all fabrics were coated uniformly and nanocomposite polymer located on/among fibers. FT-IR spectrums show presence of SMPU and SMPU-CNW nanocomposite treatment on the all fabric structures. Fabric weight values decreased with the treatment as a result of roller squeezing effect but a slight increase was observed with CNW incorporation. While bending rigidity of the fabrics treated with SMPU increased significantly (max. 5x for cotton), there is a decrease with CNW incorporation (1.73x and 1.31x for viscose and modal in turn), meaning that modal and viscose fabrics kept their hand characteristics besides gathering a passive smart function. Air permeability values increased with temperature (above Tt_{rans} of SMPU) by maximum 97% and 45% for SMPU-CNW20 treated viscose and modal fabrics respectively, with increase in porosity as a result of temperature sensitive free volume and micro-Brownian molecular motion creating micro-voids among CNWs. The mentioned is observed also for absorption capacity, increasing with temperature and reaching up the maximum values for SMPU-CNW20 treated viscose and modal fabrics (Figure 1).

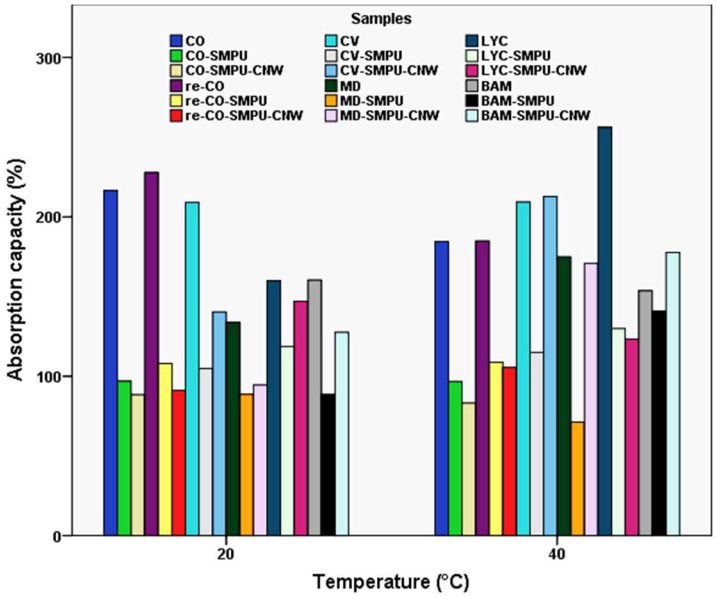


Figure 1. Dynamic absorption capacity of the fabrics with temperature change.

CONCLUSIONS

Summing up, with temperature-water sensitive nanocomposite treatment, knitted cellulosic fabrics especially the ones produced from viscose and modal gained dynamic air permeability and water absorption capacity changing within acceptable fabric hand. Shape memory polymer nanocomposite treatment may be suggested to enable enhanced thermal comfort under dynamic conditions for commonly used cellulosic knitted fabrics.

Keywords: Passive smart, cellulosic fabric, air permeability, absorption capacity.

REFERENCES

[1] https://www.textiletoday.com.bd/global-market-sports-fitness-clothing-amounts-221-3-billion-2019-2026/

[2] GARG, H., MOHANTY, J., GUPTA, P., DAS, A., TRIPATHI, B. P., KUMAR, B. Effect of heat-set temperature on the crease recovery behavior of cotton fabric dip-coated with shape memory polyurethane, Materials Chemistry and Physics, 2022, 126952.

DESIGN OF A DRYSUIT WITH IMPROVED THERMAL MANAGEMENT PROPERTIES FOR COLD WATER APPLICATIONS

Bilge Koyuncu[1], **Sena Cimilli Duru**[2], **Cevza Candan**[2], **Banu Nergis**[2], **M. Murphy Peksen**[3]
[1]*DeepTech Engineering Ltd., İzmir, Türkiye*
[2]*Istanbul Technical University, Department of Textile Engineering, Istanbul, Türkiye*
[3]*Technische Universität München, School of Engineering and Design, Munich-Germany*
b.koyuncu@deeptecheng.com

Water sports professionals who expose themselves to cold water risk experiencing an alter in body temperature that can adversely affect their performance and safety. This can result in physiological impacts such as increased strain on the heart and respiratory system, decreased muscular endurance and manual dexterity, and reduced swimming capacity. So, apparel manufacturers for cold water applications are constantly searching for new materials and/or solutions to enhance the thermoregulatory properties of such products, e.g. drysuits. Drysuits are designed to protect water sports professionals from the cold, reduce injuries and increase buoyancy [1-5]. They work by creating an insulating effect through the use of a thin pocket of water between the neoprene and skin. Traditional drysuits have a three-layer strategy where the interior layer wicks water away from the skin, the middle layer provides insulation, and the outer layer acts as a barrier to convective heat loss [6]. In order to prevent heat loss to the environment, the interior portion of the wetsuit must be made of materials with low thermal conductivity [7-8], and literature findings show that alternative advanced materials can improve performance in that respect [9]. Accordingly, this study was conducted to propose a design of drysuit with improved thermal properties for professional and semi-professional water sports enthusiasts, integrating electronic components and textiles to provide comfort, warmth, and ease-of-use.

Figure 1 shows the four layered structure of the proposed design in which the top layer of the neoprene (2 mm) wetsuit is made of classic silicone neoprene, while the first intermediate layer is a 1.5 mm spacer fabric instead of the typically used foam. Spacer fabric has a surface that carries the electronic heating circuit (Figure 2). A sensor is integrated into the spacer fabric under the neoprene (Figure 3). The second intermediate layer is single jersey (reprieve ocean) with elastane and the bottom layer is pique with elastane made of 100% recycled fibers using 37.5 yarns. This wetsuit has been engineered to meet the needs of performance athletes, with its hybrid thickness design featuring 3 mm arms, 5 mm body, and 4 mm legs, creating a balance between comfort and performance.

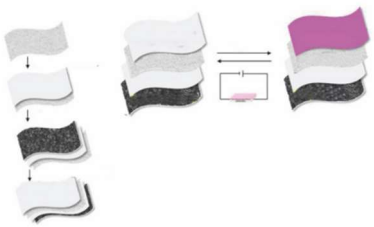


Figure 1. Four Layered structure of the drysuit

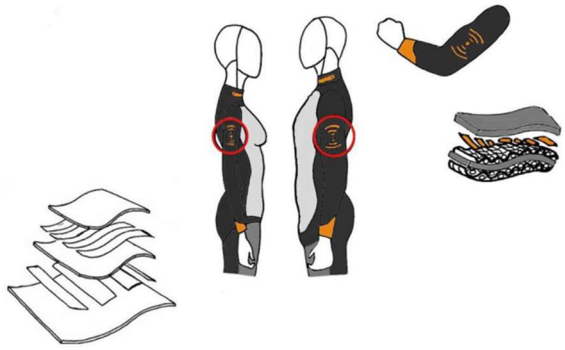


Figure 2. Heating system activation mechanism

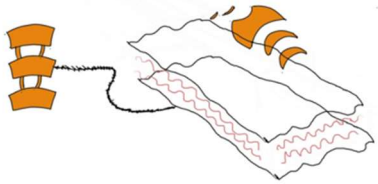


Figure 3. Sensor related activation mechanism

Table 1. Some simulation results of the heater samples

Heater	40^{0}C	45^{0}C	450^{0}C
First Layer	Max: 39^{0}C Min: 35 ^{0}C	Max: 42^{0}C Min: 34^{0}C	Max: 46^{0}C Min: 33 ^{0}C
Second Layer	Max: 40^{0}C Min: 34^{0}C	Max: 45^{0}C Min. 33^{0}C	Max: 46^{0}C Min: 33^{0}C
Spacer	Max: 40^{0}C Min: 15^{0}C	Max: 45^{0}C Min:15 ^{0}C	Max 50 ^{0}C Min 15^{0}C
Neoprene	Max 19^{0}C Min 13^{0}C	Max 21^{0}C Min 13^{0}C	Max 22^{0}C Min 13^{0}C

Using Multiphysics modelling approach, the performance of the developed suit was simulated (Table 1) and the data obtained suggested that the suit has the potential for the relevant market so far as the needs and expectations of serious water sports athletes, regulating body temperature under water and high durability, etc. are concerned.

Keywords: heating system, water sports apparel, dry suits, semi-dry suits, neoprene, simulation,

ACKNOWLEDGMENT
The authors express their gratitude to ITHIB and TIM for organizing the FutureTex Istanbul which offered a platform for us to realize the prototype of the Smart Drysuit.

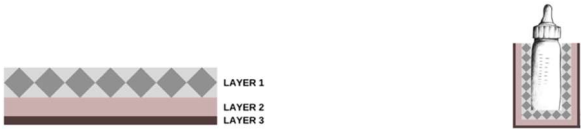
[1] CORONA, L. J., SIMMONS, G. H., NESSLER, J. A., NEWCOMER, S. C. (2018). Characterisation of regional skin temperatures in recreational surfers wearing a 2-mm wetsuit. *Ergonomics*, 61(5), 729–735. Stable Link to Article (https://doi.org/10.1080/00140139.2017.1387291)
[2] ENANDER, A. (1987). Effects of moderate cold on performance of psychomotor and cognitive tasks. *Ergonomics* 30, 1431–45.
[3] HEUS, R., DAANEN, H. A. M., HAVENITH, G. (1995). Physiological criteria for functioning of hands in the cold. *Appl Ergon* 26, 5–13.
[4] PIEDRAHITA, H. (2008). Working in cold conditions indoors: effects on musculoskeletal symptoms and upper limb movements (Ph.D), Technical University, Luleå.
[5] HOLMÉR I. (2009). Evaluation of cold workplaces: an overview of standards for assessment of cold stress. *Industrial health* (3), 228–234. Stable Link to Article (https://doi.org/10.2486/indhealth.47.228)
[6] PENG, L., SU, B., YU, A., JIANG, X. (2019). Review of clothing for thermal management with advanced materials. Cellulose (London), Vol.26 (1), p.6415-6448. Stable Link to Article (https://doi.org/10.1007/s10570-019-02534-6)
[7] LAFÈRE, P., GUERRERO, F., GERMONPRÉ, P., BALESTRA, C. (2021). Comparison of insulation provided by dry or wetsuits among recreational divers during cold water immersion (<5°C). *International maritime health*, 72(3), 217–222. (https://doi.org/10.5603/IMH.2021.0040)
[8] MATUSIAK, M. & KOWALCZYK, S. (2014). Thermal-Insulation Properties of Multilayer Textile Packages. *Autex Research Journal.* 14. 299-307. 10.2478/aut-2014-0030.
[9] NAVODYA, U., KEENAWINNA, G., and GUNASEKERA, U. (2020) The Development of Sustainable Alternative to Neoprene Wetsuit Fabric. *Moratuwa Engineering Research Conference (MERCon),* Moratuwa, Sri Lanka, 2020, pp. 465 -469, doi: 10.1109/MERCon50084.2020.9185195

HEAT ON-THE-GO: DESIGN OF A BABY BOTTLE WARMER BAG WITH A TEXTILE-BASED HEATER SYSTEM

Bilge Koyuncu[1], **Sena Cimilli Duru**[2], **Banu Nergis**[2], **Cevza Candan**[2]
[1]*DeepTech Engineering Ltd., İzmir, Türkiye*
[2]*Istanbul Technical University, Department of Textile Engineering, Istanbul, Türkiye*
b.koyuncu@deeptecheng.com

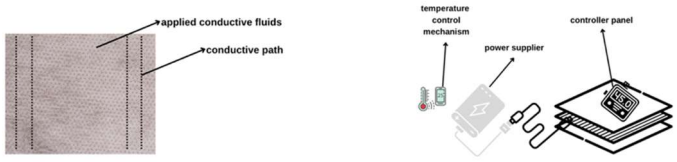
Multifunctional, high-performance wearable heaters hold great promise for various human related applications in the future [1,2]. However, their development has been impeded by challenges such as limited flexibility, inadequate air-permeability, and a lack of clothes-knittability [1,3]. Addressing these limitations, this study focuses on the textile-based design of a baby bottle heater system with a polymeric wearable heater [4]. With the help of this innovative approach, it is aimed to unlock new possibilities for advanced wearable heating technologies [5]. In the realm of baby feeding, ensuring the optimal temperature of liquid baby food is of importance for the health and comfort. Traditional methods of heating baby bottles, such as using microwave ovens, may be inconvenient and imprecise [6]. To address these challenges, portable textile-based heater systems offering uniform heat distribution, temperature control, and safety features, have emerged as a promising solution [7].

In Figure 1, the conceptual design of such a baby bottle heater whose technology is based on the TP 2015/17738 patent, that involves a 3-layer structure. The outer layer (Layer 1) is made of spacer fabric, providing cushioning and thermal insulation. The mean layer (Layer 2) comprises a textile-based heating system, responsible for generating and distributing heat evenly. (Figure 2 A). The inner layer (Layer 3) is composed of double pique fabric, chosen for its durability and aesthetics as lining material. Powder adhesives are used to bond this intermediate layer to both the outer shell and the inner lining of the system (Figure 1). This lamination process ensures the integration and stability of the different layers.



A **B**

Figure 1. A. 3 Layered textile structure of the baby bottle heater **B.** Bottle application sample.



A **B**

Figure 2. A. Textile based heating system structure **B.** Heating system activation mechanism

In Figure 2 B, the structured design of the heating system incorporates key mechanisms for optimal functionality. A temperature control mechanism is implemented to regulate the heat output and maintain the desired temperature for the baby bottle heater. A reliable power supplier ensures sufficient energy to power the heating system effectively. The controller panel provides user-friendly controls and settings to adjust the temperature as needed. The heating system activation mechanism initiates the heating process when activated, enabling efficient and controlled heating of the baby bottle contents. Table 1A shows the recorded time values for the textile surface to attain the designated temperature when using the textile-based heater within the layered structure. However, Table 1B presents the computed time for the liquid food in a commercially available baby bottle to reach the desired temperature.

Table 1. A. The time to reach the target temperature of the heated surface in the layered structure **B.** Calculated time to reach the target temperature of the liquid food in the bottle

A

The time to reach the target temperature of the heated surface in the layered structure	
Temperature ^{o}**C**	**Time** (seconds)
30	15
35	39
40	48
45	55

B

Calculated time to reach the target temperature of the liquid food in the bottle	
Temperature ^{o}**C**	**Time** (seconds)
30	59.5
35	101
40	753
45	1508

As may be seen from Table 1, the temperature range of 30 to 45 °C can be achieved with an appropriate selection of voltage applied on the heater for baby milk using the specific heating methods. This range is commonly recommended for warming baby milk to ensure it reaches a suitable temperature for consumption by avoiding nutrient loss or scalding resulted from excessive heating [9]. In future work, the focus will be on improving the heater design layer by layer such that higher energy efficiency levels can be achieved.

Keywords: heating system, baby bottle, warmer bag, wearable heating technologies, dip coating technique

ACKNOWLEDGMENT
The authors express our sincere gratitude to HASSAN for providing a sample of their patented technology for the work, which served as the foundation for the development model in this research.

[1] LIU, X., JIN X., LI L., WANG J., YANG Y., CAO Y., WANG W. (2020). Air-permeable, multifunctional, dual-energy-driven MXene-decorated polymeric textile-based wearable heaters with exceptional electrothermal and photothermal conversion performance, *Journal of Materials Chemistry A,* 25(8), 12526-12537. https://doi.org/10.1039/D0TA03048A
[2] WANG, X., LEI, Z., MA, X.J., HE, G., XU, T., TAN, J., WANG, L., ZHANG, X., QU, L., & ZHANG, X. (2022). A lightweight MXene-Coated nonwoven fabric with excellent flame Retardancy, EMI Shielding, and Electrothermal/Photothermal conversion for wearable heater. *Chemical Engineering Journal,* 430(1), 132605. https://doi.org/10.1016/j.cej.2021.132605
[3] ZANG, H., CAO Y., ZHEN Q., XU Q.G., SONG W.M., QIAN X.M. (2022). Large-Scale Preparation of Micro–Nanofibrous and Fluffy Propylene-Based Elastomer/Polyurethane@Graphene Nanoplatelet Membranes with Breathable and Flexible

Characteristics for Wearable Stretchy Heaters. *ACS Appl. Mater. Interfaces,* 14(42), 1944-8244. https://doi.org/10.1021/acsami.2c15449
[4] OJSTRŠEK A., JUG L, PLOHL O. (2022). A Review of Electro Conductive Textiles Utilizing the Dip-Coating Technique: Their Functionality, Durability and Sustainability. *Polymers.* 14(21):4713. https://doi.org/10.3390/polym14214713
[5] FARUK M.O., AHMED A., JALIL M.A., ISLAM M.T., SHAMIM A.M., ADAK B., HOSSAIN M.M., MUKHOPADHYAY SM. (2021). Functional textiles and composite based wearable thermal devices for Joule heating: progress and perspectives, *Applied Materials Today,* 23, 101025, 2352-9407. https://doi.org/10.1016/j.apmt.2021.101025
[6] EHLERT K.A., BEUMER C.W.E., GROOT M.C.E. (2007). Migration of bisphenol A into water from polycarbonate baby bottles during microwave heating, *Food Additives & Contaminants,* 25(7), 904-910. https://doi.org/10.1080/02652030701867867
[7] SIMIC M., STAVRAKIS A.K., STOJANOVIC G.M., (2022). Portable Heating and Temperature-Monitoring System with a Textile Heater Embroidered on the Facemask, *American Chemical Society,* 7(50), 47214-47224 https://doi.org/10.1021/acsomega.2c06431
[8] Şişman, A. (2015)Köprü Viyadük ve Otoyollarda Donmayı Geciktirmeye veya Engellemeye Yönlik Tülbent Esaslı (Non-Woven) Sentetik Malzeme Geliştirilmesi (TP Patent No: 2015/17738) Türk Patent
[9] American Academy of Pediatrics (2017) Tips for Introducing Solid Foods, *Healthy Children*

DIGITAL TRANSFORMATION AND ITS EFFECTS ON PRODUCTIVITY IN A CLOTHING COMPANY

Mehmet KÜÇÜK[1], Safak BİROL[2]
[1] Ege University Engineering Faculty Textile Engineering Department, Izmir, Türkiye
[2] TYH Izmir R&D Center, Türkiye
safak.birol@tyh.com.tr

60% of all personnel in a clothing company work in the production department [1]. In this department, difficult, complex machines or apparatuses, each with different features, are used by the operators. However, all the activities performed are highly dependent on the dexterity and performance of the operator [2]. The fact that the data obtained from all the activities carried out in the production department (such as the number of production) is human-dependent, means that these entries depend on a subjective structure [3].

The common problem of apparel enterprises is that there is a lower efficiency than the planned values. In this direction, it is the managers' inability to reach the desired and correct data in a timely manner. When the sector practices are examined, it is found that no integrated system provides the automatic calculation of standard work times, the creation of an operation-related cycle time bank, the elimination of order-related production line imbalances, and the control of stocks in the line. In the scope of the study, it is planned to develop a digital system that can monitor and calculate operational efficiency and operator performances, respond to problems immediately, and perform line balancing.

The digitalization cycle is completed in 3 phases. These; digitization, digitalization, and digital transformation. Digitization occurs when a product becomes digital. Digitalization occurs when a business model becomes digital. Digital transformation, on the other hand, is the restructuring of the business world, society, economy, and institutions with a digital system [4].

Figure 1. The digital transformation steps-the three amigos [4]

In the study, digital transformation was achieved in all processes of the production department by following these 3 steps in line with the Industry 4.0 philosophy. In the first step of the transformation, internet-based (IOT) data collection devices were developed under the title of digitization. Since there are many deviations in the data collected by manual-semi-automatic systems in the existing sewing enterprises and cause erroneous results, it is ensured that the correct data is obtained directly from all sewing machines, without being dependent on people, through sensors and RFID technologies. Three different IOT data collection devices were developed and set to cover the assembly line, quality control, and packaging processes in a sewing line.

In the second step of the transformation, a digital production management system “The MES platform” was developed, where instantaneous and online data collected from the line can be managed. With this platform, it has been ensured that the sewing lines are managed effectively and productivity is increased by optimizing them with the correct data. In this direction, it is ensured that;

- Production data is collected with a notification system,
- Accurately detecting lost times,
- Keeping cycle time bank records over real operation times,
- Doing competence analysis by assigning the appropriate operator for the appropriate operation,
- Optimizing the stocks in the line on the system,
- Creating a line balancing plan that provides a balanced workload and a balanced flow and monitoring compliance with this plan.

In the last step of the transformation, the integration of the developed IOT and MES platforms both among each other and into the currently used ERP system was ensured. The technical infrastructure has been established for the flow of the data needed for production on the MES platform to the ERP system.

In the results,

- The characteristic features of more than 500 sewing operations are listed in the "Operation Bank", with this way standardization, and methodological improvement in production have been achieved.
- Fast and realistic assignments were made with the multi-criteria operator competence analysis system (CAS) developed specifically for sewing operators.
- With the machine management module, inventory lists were created that provide information about the location and occupation of the machines in the production facility.
- Alternative production scenarios can be created automatically with the developed competency-based line balancing algorithms.
- A system has been developed in which production and quality data are automatically reported and in-line stock tracking can be done instantly.
- Efficiency, performance and quality reports can be prepared on the basis of order, facility, band, operator, operation within the desired time period.

The developed system was set up on a pilot band with 25-30 sewing machines, 3 quality control stations, 1 packaging station, with an average of 40 operators, and was evaluated in a 3-month period. In this direction;

- An increase of 14.75% in sewing efficiency,
- An increase of 18.55% in quality efficiency,
- A 15.3% increase in overall sewing line efficiency has been detected.

Keywords: industry 4.0, ERP, MES, IOT, Digital transformation, clothing

ACKNOWLEDGEMENT

This study was supported by the TUBITAK 1501 Project (Project ID: 3189129)

REFERENCES

[1] KÜÇÜK M. and GÜNER M., The productivity improvement studies with process analysis methods in a clothing company, Tekstil ve Mühendis, 2015, 22:98, 33-41.
[2] SNATKINA A., KARJUSTA K., MAJAKA J., ARUVÄLIA T., EISKOP T., Real time production monitoring system in SME, Estonian Journal of Engineering, 2013, 19:1, 62–75.
[3] ZERENLER, M., The performance measurement system design and a study on performance measurement of manufacturing systems, The International Journal of Economic and Social Research, Spring 2005, 1:1-36.
[4] https://www.dbi.srl/solutions/digital-business-transformation/ (10.05.2023)

THE ADVANCED TECHNOLOGY FOR COMPRESSION GARMENT DESIGN

Olena Kyzymchuk[1,2], Yordan Kyosev[1], Liudmyla Melnyk[2], Jessica Boll[1]
[1] *Technische Universität Dresden / Hohe straße 6, 01069 Dresden, Germany*
[2] *Kyiv National University of Technologies and Design / Mala Shiyanovska street, 2; 01011 Kyiv, Ukraine*
olena.kyzymchuk@mailbox.tu-dresden.de

Compression garment are skin-tight elastic garment designed to apply pressure to a certain part of the body. It is widely used in professional sports for better performance and recovery after exercise [1], the garments with a slight pressure designed are becoming more popular for body shaping purpose [2]. And of course it have been utilized for medical reasons for many years [3],[4]: in the treatment of burns (scar management), low blood pressure, muscle strains and sprains; to accelerate the healing process and prevent deep vein thrombosis, oedema etc. The compression garment should be made in huge diversity of the sizes and the shapes to follow the body`s contours and to suit different body types and parts. The performance of such product (pressure level and rigidity) depends greatly on end-use and functionality.

The correct adaptation of compression clothes to the individual geometry of the body is an important aspect both compression effect and clothes comfort [5]. Ussually, the appropriate girths and lengths are collected with a measuring tape (for example, for the leg), and then the compression garment is selected according to the compression level and the size table of the current standard [6]. Pre-sized garments available from number of commercial companies in a variety of styles and sizes for all body parts, but they do not normally fit patients perfectly. The scientists around the world are working to improve understanding of the main points of designing compression clothing [7] .

With improvement 3D scanning technology, new approach to design the compression garment was developed based on virtual method [9], which has few stages. The investigation of system “body-compression garments” is the most important one and less studied despite many works in the area [8]. They are mostly focused on flattening of the 3D surface that has ‘‘negative ease’’ compared to the surface of the avatar [9] or/and create the high accuracy model to predict the pressure at the intended points on the human body [10].

The main goal of this research is study the individual geometry of the lower leg and the changes of their sizes and shapes within wearing time of stockings and different activity as well as changes in pressure occurred at the same time. The study focuses on 4D body scanning as tool for high quality personal compression garments development.

The modular photogrammetry based 3D/4D capture and analysis system MOVE 4D at ITM TU Dresden make it possible to capture body movement with frequency 20 frame per sec. The scanning was done for control leg and within stocking wearing at standing position and different activity (Fig. 1). Conventional stocking and two types of compression stockings (I and II classes) were used. The measurements were done between ankle (10 cm from floor) and calf (30 cm from floor). MeshLab and ParaView software was used for data processing, measuring leg sizes changes and comparisons the legs shapes.

The texsens force and pressure measuring device developed by novel.de were used. Measurement time was 60 sec (1 min) with 0.02 sec frequency. The examples of pressure measurement during different activity with conventional stocking are presented in fig. 2.

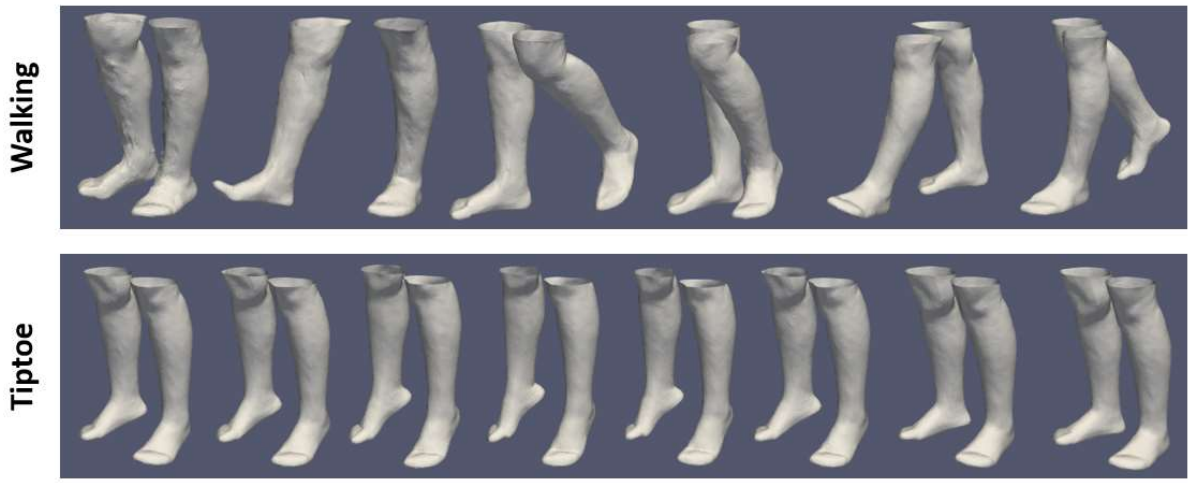


Figure 1. Examples of captions of lower leg during activity

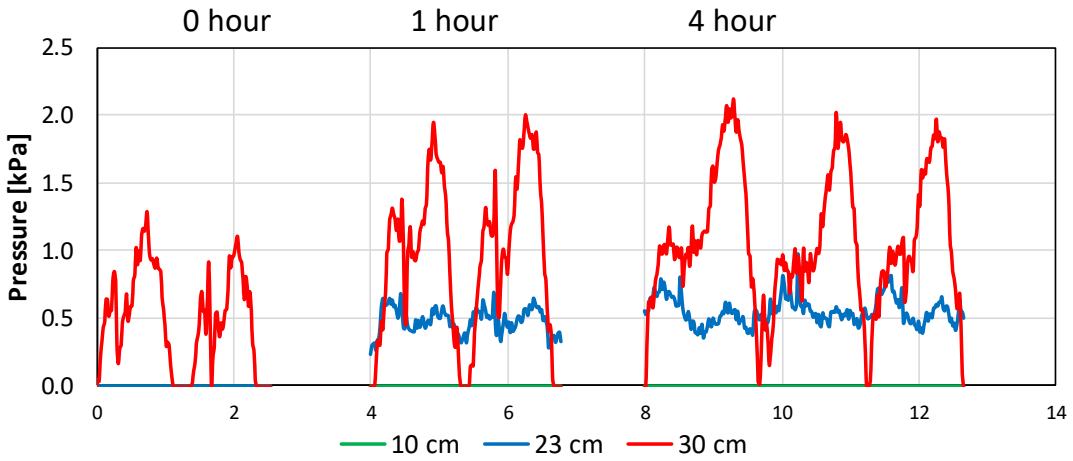


Figure 2. Examples of measurements the pressure by conventional stocking during walking

The research results show that changes in leg size (circumferences and areas) leads to changes in pressure level delivered by stockings. By processing data it was clarified the compression stocking of which class more effective and more useful for scanned person. It could be conclude that the scanning allows the quick estimation the compression stockings functionality.
From the other side, avatar of certain person and the real data of his sizes are the initial point for individual stocking creation and it will be followed by development a tool for high accuracy ready-to-wear compression garments design.

Keywords: 4D body scanning, static and dynamic position, lower leg, body size and shape, compression stocking

ACKNOWLEDGEMENTS
The authors would like to thank Philipp Schwartz Initiative from the Alexander von Humboldt Foundation for Ukrainian scientist for project`s supporting at Technische Universitat Dresden, Germany.

References

[1] ENGEL, F., SPERLICH, B., editors. Compression garments in sports: Athletic performance and recovery. Geneva, Switzerland: Springer International Publishing; 2016 Jul 12. https://doi.org/10.1007/978-3-319-39480-0
[2] YAMADA, T., MATSUO, M. Clothing Pressure of Knitted Fabrics Estimated in Relation to Tensile Load Under Extension and Recovery Processes by Simultaneous Measurements. Textile Research Journal, 2009, vol. 79, no 11, pp: 1021-1033. doi:10.1177/0040517508099387
[3] XIONG, Y., TAO, X. Compression Garments for Medical Therapy and Sports. Polymers, 2018, vol. 10, no 6, 663, pp: 1-19. https://doi.org/10.3390/polym10060663
[4] GOKARNESHAN, N. Design of compression/pressure garments for diversified medical applications. Biomedical Journal of Scientific & Technical, 2017, vol. 1, no 3, pp: 1-8. DOI:10.26717/BJSTR.2017.01.000309
[5] ABOALASAAD, A.R.R., KOLČAVOVÁ, B.S. and BERK, G.G. Effect of Compression Bandages on Muscle's Behavior, 18th World Textile Conference (AUTEX 2018) 20–22 June 2018, Istanbul, Turkey, IOP Conference Series: Materials Science and Engineering. 2018, vol. 460, 012034 DOI 10.1088/1757-899X/460/1/012034
[6] RAL GZ 387-1: 2008. Medical compression hosiery. Quality assurance. Deutsches Institut F. Guetesicherung und Kennzeichnung
[7] LIU, R., GUO X., LAO T.T. and LITTLE T. A critical review on compression textiles for compression therapy: Textile-based compression interventions for chronic venous insufficiency. Textile Research Journal, 2017, vol. 87, no 9, pp: 1121-1141. doi:10.1177/0040517516646041
[8] TYURIN, I., GETMANTSEVA, V. and ANDREEVA, E., 3A1_0366_ The finite-element modelling of compression sportswear, Autex 2019 : 19th World Textile Conference : Textiles at the crossroads, 11-15 June 2019, Ghent, Belgium, Proceedings, 2019, 2. https://openjournals.ugent.be/autex/article/id/63797/
[9] KUZMICHEV, V.E., TISLENKO, I.V. and ADOLPHE D.C. Virtual design of knitted compression garments based on bodyscanning technology and the three-dimensional-to-two-dimensional approach, Textile Research Journal, 2019, vol. 89, no 12, pp: 2456-2475. doi:10.1177/0040517518792722
[10] JARIYAPUNYA N., and MUSILOVÁ, B. Predictive modelling of compression garments for elastic fabric and the effects of pressure sensor thickness, The Journal of The Textile Institute, 2019, vol. 110, no 8, pp: 1132-1140, DOI: 10.1080/00405000.2018.1540285

TEXTILE REINFORCED CONCRETE: A COMPREHENSIVE REVIEW

Elifsu Hazal Morgül[1], Güldemet Başal Bayraktar[2], Sevda Altaş[3]
[1] Ege University / Textile Engineering / Bornova, Izmir
[2] Ege University / Textile Engineering / Bornova, Izmir
[3]Ege University / Emel Akın Vocational School / Bornova, Izmir
elifsumorgul7@gmail.com

Textile Reinforced Concrete (TRC) is an innovative building material that combines the durability of concrete with the strength, flexibility, and versatility of textiles. This review presents an analysis of TRC, covering its composition and manufacturing methods, mechanical properties, durability, and potential applications. It concludes with a discussion on some current challenges and future prospects of TRC. The review aims to enhance existing knowledge and highlight research advances in the area by providing valuable information for researchers and engineers in the textile and construction fields.

COMPOSITION AND MANUFACTURING METHODS

TRC is generally manufactured by impregnating the textile reinforcement material with the concrete matrix. The concrete matrix contains cement, aggregates, and water [1]. The textile reinforcement part consists of various types of fibers, including glass, carbon, aramid, basalt[2], and natural fibers, such as jute, flax, or hemp[3]. These fibers are generally used in two forms: as staple fibers or as fabric[4].

MECHANICAL PROPERTIES

TRC has outstanding mechanical properties that make it particularly suitable for structural applications. The textile reinforcement enhances the tensile strength, ductility, and crack control of the concrete. The mechanical properties of TRC mainly depend on design parameters such as fiber type, textile form, fiber-to-mortar bonding strength, fiber volume fraction, and manufacturing conditions, and environmental parameters such as temperature and humidity [5].

DURABILITY

Similar to mechanical properties, the durability of TRC structures depends on the type of textile reinforcements and matrix, and the severity of the environmental conditions. In order to increase durability a fiber surface treatment can be applied or appropriate protective measures can be taken[6].

APPLICATIONS

TRC has already been used in numerous applications. Some of these applications are ventilated facade systems, sandwich walls, storage units, bridges, and load-bearing shell structures[7]. TRC is particularly preferred for precast elements due to its lightweight nature and high tensile strength. Furthermore, more complex architectural shapes can be easily realized with TRC since it has a very high formability[8].

CONCLUSION AND FUTURE PROSPECTS

The desire for producing more efficient and sustainable structural systems for construction industry has led to development of Textile Reinforced Concrete (TRC) . Incorporation of TRC to building structures allowed reducing material usage and cost. Today, TRC is not only used

for newly fabricated structural elements, but also used for the strengthening of existing structures. Advances in TRC continue to create new opportunities for the application of concrete. It seems that TRC will revolutionize the way we construct buildings in the future.

Keywords: textile reinforced concrete; fiber; textile; matrix

REFERENCES

[1] D. FRIESE, M. SCHEURER, L. HAHN, T. GRIES, C. CHERIF, Textile reinforcement structures for concrete construction applications—a review, J. Compos. Mater. 56 (2022) 4041–4064. https://doi.org/10.1177/00219983221127181.
[2] V. AFROUGHSABET, L. BIOLZI, T. OZBAKKALOGLU, High-performance fiber-reinforced concrete: a review, J. Mater. Sci. 51 (2016) 6517–6551. https://doi.org/10.1007/s10853-016-9917-4.
[3] L. YAN, B. KASAL, L. HUANG, A review of recent research on the use of cellulosic fibres, their fibre fabric reinforced cementitious, geo-polymer and polymer composites in civil engineering, Compos. Part B Eng. 92 (2016) 94–132. https://doi.org/10.1016/j.compositesb.2016.02.002.
[4] S.G. VENIGALLA, A.B. NABILAH, N.A.M. NASIR, N.A. SAFIEE, F.N.A. ABD AZIZ, Textile-Reinforced Concrete as a Structural Member: A Review, Buildings. 12 (2022). https://doi.org/10.3390/buildings12040474.
[5] P. RAWAT, S. LIU, S. GUO, M. ZILLUR RAHMAN, T. YANG, X. BAI, Y. YAO, B. MOBASHER, D. ZHU, A state-of-the-art review on mechanical performance characterization and modelling of high-performance textile reinforced concretes, Constr. Build. Mater. 347 (2022). https://doi.org/10.1016/j.conbuildmat.2022.128521.
[6] H. JAMSHAID, R. MISHRA, J. MILITKÝ, M.T. NOMAN, Interfacial performance and durability of textile reinforced concrete, J. Text. Inst. 109 (2018). https://doi.org/10.1080/00405000.2017.1381394.
[7] C. KULAS, Actual Applications and Potential of Textile-Reinforced Concrete, Int. Congr. Ser. 1247 (2015).
[8] J. HEGGER, M. CURBACH, A. STARK, S. WILHELM, K. FARWIG, Innovative design concepts: Application of textile reinforced concrete to shell structures, Struct. Concr. 19 (2018). https://doi.org/10.1002/suco.201700157.

TEA TREE OIL LOADED NANOFIBERS FOR WOUND DRESSING APPLICATIONS

Seniha Morsümbül[1], Emriye Perrin Akçakoca Kumbasar[1], Ahmet Çay[1], Aylin Şendemir[2], Sait Berkay Çetintaş[3], Ecenaz Merve Namlı[4]

[1] Ege University, Faculty of Engineering, Department of Textile Engineering, İzmir, Türkiye
[2] Ege University, Faculty of Engineering, Department of Bioengineering, İzmir, Türkiye
[3]Ege University, Graduate School of Natural and Applied Sciences, Department of Textile Engineering, İzmir, Türkiye
[4]Ege University, Institute of Health Sciences, Department of Stem Cell, Izmir, Türkiye
perrin.akcakoca@ege.edu.tr

Nanofibrous surfaces which have many application areas due to their wide surface area and high porosity, are produced by the methods such as bicomponent fiber production, electrospinning, phase separation, template synthesis and meltblown. Among these methods, electrospinning, which offers the opportunity to study with many different polymers, stands out as a relatively easier and economical method especially in laboratory conditions.

Electrospun nanofibrous surfaces can gain functional properties due to the type of polymer used or the active ingredients added to the polymer solution. Since increasing environmental and health problems in recent years, the use of natural ingredients has become more remarkable for the functionalization of electrospun nanofibers. Essential oils which are complex substances of natural volatile compounds that can functionalize the nanofibrous materials due to their antimicrobial, antifungal and anti-inflammatory etc. properties.

In this study, tea tree oil loaded nanofibrous surfaces were produced. Thermoplastic polyurethane was selected as polymer in the nanofiber production. The spinning solutions were prepared by adding tea tree oil to the polymer solution, and then nanofibers were produced by electrospinning method. Characterization of the nanofibrous surfaces were evaluated by scanning electron microscopy. The antibacterial activities and the cytotoxicity properties were evaluated by disk diffusion and extraction methods, respectively.

As a conclusion, it was observed that smooth nanofibers could be obtained, these nanofibrous surfaces had antibacterial properties and did not show cytotoxicity. Thus, it is thought that tea tree oil loaded nanofibrous surfaces may have a potential to be used in wound dressing applications.

Keywords: Essential oil, nanofiber, electrospinning, antibacterial, cytotoxicity.

THE PRESSURE CHARACTERISTICS OF ELASTIC WARP KNITTED FABRICS

Nida Oğlakcıoğlu[1], Arzu Marmaralı[1], Olena Kyzymchuk[2,3], Berna Cüreklibatır Encan[1], Gözde Ertekin[1], Liudmyla Melnyk[2]

[1] Ege University, İzmir, Türkiye
[2] Kyiv National University of Technologies and Design, Kyiv, Ukraine
[3] Technische Universitat Dresden, Germany
olena.kyzymchuk@mailbox.tu-dresden.de

Medical textiles are an essential sub-group of technical textiles. With the use of textile products for medicinal purposes, diseases could be prevented or healed. As the life expectancy of humans extends and individuals become less active, medical conditions regarding the musculoskeletal system have become prevalent. For the treatment of these medical problems, elastic textile materials, such as corsets, bandages, posture correctors, wristbands, etc., are suggested by physicians. These elastic textile products must have various physical and mechanical properties to provide comfort for the user and fulfill their duty. Such properties are elongation, elasticity, air and relative water vapor permeability, thermal conductivity/resistance, and compression. Characteristics required to provide the necessary compression usually go against with the properties related to comfort. Therefore, an optimum balance between compression and comfort should be maintained.

In this study, elastic warp-knitted samples suitable for medicinal use were produced with different guide bar threading arrangements and weft yarn materials. The elastic warp-knitted fabrics were produced on a 15-gauge, T.C.H. crochet knitting machine with four guide bars. Yarn feeding tension, fabric takedown load, and the number of used needles were kept constant for all samples. The closed pillar stitches (Figure 1(a)) were knitted using 16.7 tex polyester threads which were fed from a fully threaded guide bar for the ground. The 0.8 mm diameter polyurethane thread was longitudinally fed into the knitting zone with a preliminary elongation of 270%. To determine the influence of the guide bar threading arrangement on the fabric structure and parameters, five different polyurethane threading options were used as given in Table 1. The other two guide bars (Figure 1(c) and (d)) were used to insert weft yarns in the transverse direction on both sides of the polyurethane threads. Four different yarns were used as weft yarns to create elastic fabrics with various raw material compositions (Table 2).

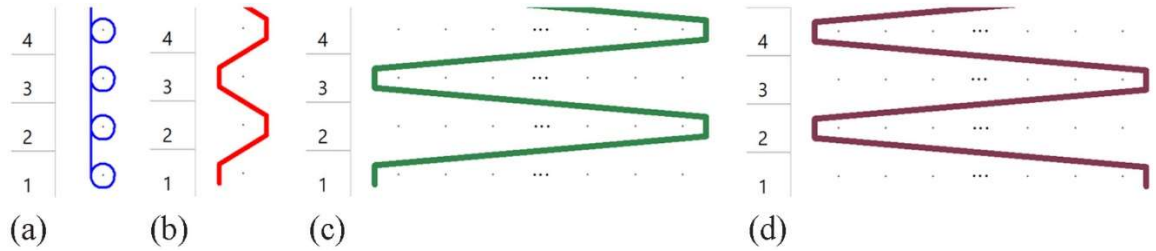


Figure 1. Lapping diagram: (a) first guide bar (pillar stitch), (b) third guide bar (elastomer thread), and (c) and (d) second and fourth guide bars (weft yarns).

Table 1. Threading of elastomer thread and type of weft yarn materials

Threading			Type of materials	
I	1 in, 1 out (50 %)		PET 2	33.4 tex polyester (96 filaments) 2 ply
II	2 in, 1 out (67 %)		PET 4	33.4 tex polyester (96 filaments) 4 ply
III	3 in, 1 out (75 %)		COT	29.0 tex cotton yarn 4 ply
IV	Full (100%)		LIN	29.0 tex linen yarn 4 ply

According to the experimental plan, 15 variants of elastic warp-knitted fabrics which have different threading arrangements for elastomer threads and different raw materials for weft yarn were manufactured. In our former study, the structural and elastic properties of the samples (mass per unit area, stitch density, thickness, and elastic behavior) were determined [1]. In the following research, the thermal comfort properties of the samples (fabric density, air permeability, thermal conductivity, thermal resistance, and water vapor resistance) were tested [2]. Investigating the effect of elastomer threading arrangement and weft yarn material on compression characteristics of the samples was aimed in this research. The pressure exerted by elastic textile materials depends on their structural properties such as raw material, fabric structure, elongation, elasticity, and additionally the diameter of the usage area. In order to obtain different extension values (8%, 20%, and 32%), three measurement disks have different diameters (8, 9, and 10 cm). The pressure measurements were taken with a Kikuhime pressure monitor.

The pressure results were evaluated according to weft yarn type, threading arrangement of elastane threading, and extension. It was revealed that pressure increased with the increment of elastane and extension ratios. Besides, cotton and linen samples exhibited higher pressure (Figure 2) due to their lower extensibility.

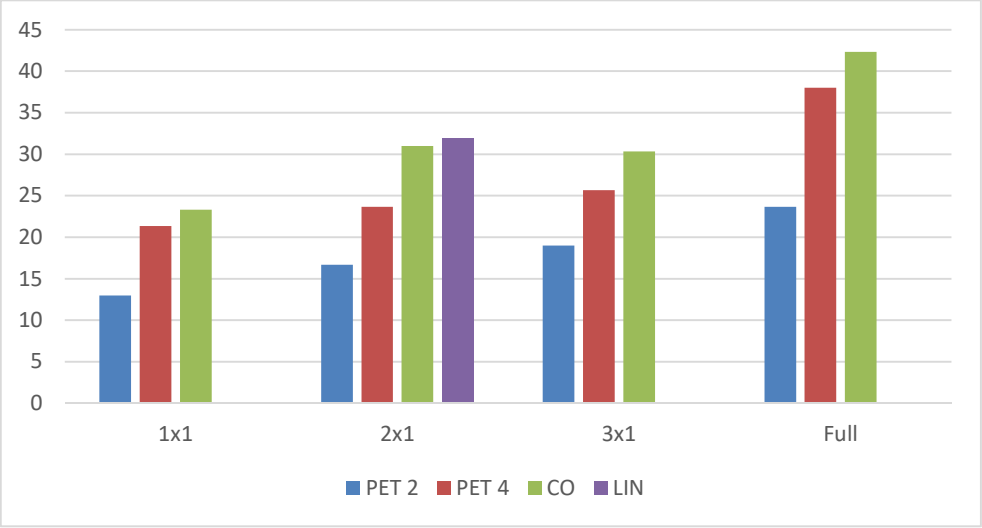


Figure 2. Pressure results at 8% extension

Keywords: Warp knitting, medical textiles, laid-in yarn, elastomer threading, compression

REFERENCES

[1] KYZYMCHUK, O., MELNYK, L., MARMARALI, A., OĞLAKCIOĞLU, N., ERTEKİN, G., ARABULI, S., ARABULI, A. and CÜREKLİBATIR ENCAN, B. The effect of weft yarn type and elastomer yarn threading on the properties of elastic warp knitted fabrics. Part 1: Structure and elasticity [cited 22.05.2023]. Available on https://doi.org/10.1177/15589250231167405

[2] KYZYMCHUK, O., MARMARALI, A., MELNYK, L., OĞLAKCIOĞLU, N., ERTEKİN, G., CÜREKLİBATIR ENCAN, B., ARABULI, S. and ARABULI, A. The effect of weft yarn type and elastomer yarn threading on the properties of elastic warp knitted fabrics. Part II: Thermal comfort properties [cited 22.05.2023]. Available on https://doi.org/10.1177/15589250231171582

BRINGING SUSTAINABLE FIBER FROM STEM, LEAF AND FOOD PRODUCT WASTE TO RING SPINNING TECHNOLOGY

Neslihan Okyay[1], Fatih Işik[2], Sümeyye Kes[3]
[1,2,3] *Karacasu Tekstil Ar&Ge Departmanı / Kahramanmaraş*
nes@karacasutekstil.com.tr

ABSTRACT
In the textile industry, the increasing number of consumers and the fast fashion trend that causes the demand to be always high, the consumption of non-renewable raw materials and the production of natural fiber are also under pressure; puts the consumption of resources in our world in great danger. In recent years, this industry, like many other industrial areas, has been in search of solutions that support sustainability in raw material selection and production methods. During the production of natural vegetable fibers, tons of agricultural wastes such as food,stems and leaves are generated. These wastes need to be disposed of in a beneficial way as the ecosystem cycle. In this sense, it is important in terms of fashion, product diversity and environment that the sustainable fiber obtained by converting crop wastes such as banana stalks and pineapple leaves into a biodegradable sustainable fiber through a mechanical process, into ring short fiber spinning technology. For this reason, within the scope of the study, yarns from the blends of this new and environmentally friendly fiber with cotton and tencel, and knitted fabrics from these yarns were developed and their yarn and fabric performances were measured and evaluated.

INTRODUCTION
With the rapid factorization and the emergence of mass production in textile industry, the use of traditional production methods has decreased, and besides, natural raw materials could not meet the need, and the use of synthetic fibers and mass production in the textile and fashion industries had devastating effects on the environment and ecosystem. Global annual fiber production in 2017 was over 105 million tons (Mt), with polyester (53.7 Mt) and cotton (25.8 Mt) accounting for 76% of the total; regenerated cellulosics (eg lyocell, viscose; 6.7 Mt), other plant fibers (eg flax, hemp; 5.6 Mt), polyamides (5.7 Mt), polypropylene (6 Mt), wool (1.2 Mt) Mt) and other natural fibers (0.4 Mt) appear to make up the rest[1]. From this point of view, it is known that the use of synthetic raw materials in the textile sector is high and therefore the environmental burden of the sector increases. Here, in order to reduce the use of synthetic raw materials, not only natural fiber production is sufficient, but also environmentally friendly alternative raw materials that serve zero carbon footprint targets should be brought to the textile industry by adding the wastes generated in the production processes to the cycle. The raw material to be used within the scope of the study is a biodegradable textile fiber produced from low value agricultural wastes including oilseed hemp, oilseed flax, wheat, rice, corn, pineapple leaves, banana stems and more.

MATERIAL-METHOD
Within the scope of the study, performance tests were applied by spinning ring yarn of Ne 24/1 fineness, 15% Sustainable Fiber 85% Cotton and 15% Sustainable Fiber 85% Tencel. Then, knitted fabrics were obtained from these yarns in a 30 pus 28 circular knitting machine. Test results were evaluated by applying pilling test to these fabrics. The quality test values of sustainable fiber blended yarns are given in Table 1.

Table 1. Evenness and Strength Test Results of 24/1 Sustainable Fiber /Cotton15/85 and 24/1 Sustainable Fiber /Tencel 15/85 Yarns

Quality Parameters	24/1 Sustainable Fiber /Cotton15/85	24/1 Sustainable Fiber /Tencel 15/85
Unevennes (%CVm)	24,71	21,39
Thin place (-50%)	287	14
Thick place (+50%)	2436	1822
Neps (+200%)	3319	3047
Strength RKm (kgf.Ne)	14,37	28,99
Elongation (%)	6,15	9,63
B-Work (N.cm)	5,67	20,49

Pilling, moisture transmission and air permeability tests were applied to fabrics obtained from sustainable fiber blended yarns. Pilling test results are given in Table 2.

Table 2. Pilling Test Results of 24/1 Sustainable Fiber/Cotton15/85 and 24/1 Sustainable Fiber/Tencel 15/85 Yarns

Cycle	24/1 Sustainable Fiber /Cotton15/85	24/1 Sustainable Fiber /Tencel 15/85
125	5	5
500	5	5
1000	5	4
2000	4	4
3000	4	4
4000	4	3
5000	4	3

RESULTS

In this study, when the unevenness values of sustainable yarns obtained by mixing the fiber obtained from stem, leaf and food waste with cotton and tencel fiber are examined, it is seen that the tencel blended yarn has better values than cotton yarn. Considering the yarn strength results, it is seen that the strength of the sustainable fiber/tencel blended yarn is higher than the cotton/sustainable fiber blended yarn. This is due to the strength of tencel fiber being 40 cN/tex. However, when the B-Work values of these two yarns are examined, it is seen that it will not pose a problem for circular knitting machine performances. Among the knitted fabrics obtained from these yarns, it was observed that cotton/sustainable fiber blended fabric had better pilling performance and no pilling on the fabric surface. The reason why the piling of the sustainable fiber tencel blended fabric is higher than the cotton work is due to the fact that the pilling cannot be easily separated from the surface due to the high fiber strength of the tencel fiber.

It is predicted that by bringing the sustainable fiber used within the scope of the study into short fiber spinning, it will contribute to the prevention of climate changes that negatively affect the vital functions of all living things by reducing the carbon footprint. In addition, the microscope image of the developed yarn and the moisture transmission and air permeability tests of the fabrics will be included in the full text.

Keywords: Sustainable Raw Material, Ring Spinning Technology, Agricultural Waste

REFERENCES

[1] STENTON, M., HOUGHTON, J. A., KAPSALI, V., & BLACKBURN, R. S. The Potential for Regenerated Protein Fibres within a Circular Economy: Lessons from the Past Can Inform Sustainable Innovation in the Textiles Industry. 2021. Sustainability, 13(4), 2328.

MICROWAVE ENERGY-BASED APPROACH TO PREPARATION AND CHARACTERIZATION OF FUNCTIONAL TEXTILES FOR FIBER REINFORCED POLYMERIC COMPOSITES

Selçuk Poyraz
Department of Textile Engineering, Faculty of Engineering, Adıyaman University, Adıyaman 02040, Turkey
spoyraz@adiyaman.edu.tr

ABSTRACT
Through a facile, simple, yet efficient, affordable and ultrafast (30 s) microwave (MW) energy-based process, i.e. Poptube approach, hierarchically structured functional textiles made up of carbon fiber (CF) or glass fiber (GF) fabrics decorated with multi-walled carbon nanotube (MWCNT) forest were produced effectively at ambient conditions. Both the morphological and elemental properties of the as-produced samples were characterized in details by using scanning and transmission electron microscopy (SEM, TEM), and the elemental analysis (EDX) techniques. The material characterization results, and the versatile and easily controllable working principle of the above-mentioned approach strongly supports its promising success for the preparation of such functional textiles that could be effectively used as fibrous reinforcing agents for the manufacturing of next-generation high performance fiber reinforced polymeric composite structures (FRPCSs).

Keywords: Microwave energy, carbon nanotube, carbon/glass fiber, conducting polymer, functional textile

INTRODUCTION
The major objective of this study is to explore novel MW energy-based nano-engineering technique, i.e. Poptube approach, for the development of FRPCSs that have been extensively implemented in various high-tech industries including aerospace, automotive, renewable energy, civil infrastructure, and sports with respect to their higher specific strength and stiffness, lighter weight, and better fatigue and corrosion resistance along with superior mechanical performance and durability. One of the best candidates to obtain a FRPCS, which is typically composed of reinforcing micro/nanofibers or textiles, polymeric matrix, and the interface constituents, is CNT due to its extraordinary mechanical, thermal and electrical properties. Compared to other conventional structural additive materials, CNTs exhibit much higher strength (tensile strength >100 GPa), stiffness (Young's modulus of ~1.5 TPa), and flexibility (20-30% at failure). Thus, CNT reinforcement possesses promising potential to provide much stronger and tougher materials than other traditional reinforcing materials. Besides that, such properties of CNTs enable functional advantages such as self-sensing abilities, flame retardancy, long-term wear resistance, electrical and thermal conductivity, electromagnetic interference (EMI) shielding, and improved thermal stability to the added structure. Here, Poptube approach provides a unique way to grow CNTs on fibrous textile materials within very short time frame and low-cost by using ME. However, the application of CNTs into FRPCS is hampered by three major problems about; (i) the nonhomogeneous dispersion of such nanoscale additives within the structure, (ii) the inconsistency in the implementation of laboratory results to the industrial scale, and (iii) the failure in lowering the cost/benefit ratio. This study aims to address all these problems through Poptube approach. Unlike any other similar existing methods, such as chemical vapor deposition (CVD), Poptube approach utilizes ME as the heating source, a metallocene precursor chemical, e.g. ferrocene, as the source for both carbon and the metal catalyst, and conducting polymer (CP), e.g. polypyrrole (PPy), coating as the

effective MW absorption layer on the fibrous textile material surface. Thus, it becomes possible to grow massive forest-like CNT decoration on the fibrous textile substrates' surface, such as CF and/or GF fabric, which would be used as a reinforcing agent in FRPCS. With that, the Poptube approach not only can be considered as the fastest method to grow CNTs with high energy and cost efficiency, but also as a readily scalable approach for high-volume industrial manufacturing processes. It is also envisioned that this study will enable to broaden the CNTs application in new generation high-performance FRPCS production.

EXPERIMENTAL

Materials: Plain weave CF and GF fabric, acetone (JT Baker), toluene (JT Baker), pyrrole, ammonium peroxy disulfate (APS), hydrochloric acid (HCl) and ferrocene (AlfaAesar) were all used as purchased without further purification, unless otherwise specified.

Method: Typically, there are three major steps of; i) applying a thin CP layer coating* on the substrate (*only if it is insulating) surface through in-situ polymerization reaction, ii) submerging the as-prepared CP-coated substrates into ferrocene solution, iii) exposing the drip-dried sample to short term (30 s) MW energy in a conventional MW oven, are required to grow CNTs on fibrous textile substrates via Poptube approach. Eventually, forest-like grown CNTs could be obtained on the substrate as a homogenous surface decoration. Upon MW irradiation, firstly, CP surface coating effectively absorbs the energy, gets quickly carbonized, and releases tremendous amount of heat. The temperature on the substrate surface is then rapidly raise high enough to get ferrocene to decompose into its iron (Fe) and cyclopentadienyl fragments. Here, Fe would serve as the catalyst and the cyclopentadienyl groups would provide the carbon source to accomplish the CNT growth. A schematic representation of the above-mentioned process is shown in Figure 1.

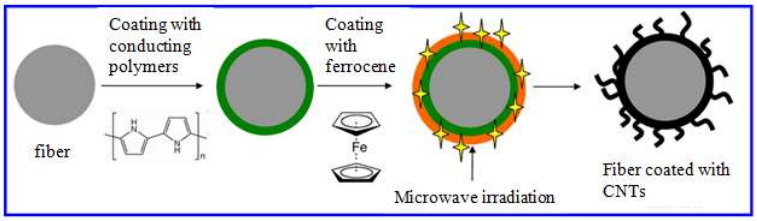


Figure 1. Schematic representation of CNT growth on fibrous textile substrate via MW energy-based Poptube approach

RESULTS AND DISCUSSION

As a result of the application of Poptube approach, a dense forest-like CNTs were grown on the CP coated GF fabric surface and covered majority of the fiber surface with a radially aligned and entangled assembly look, as clearly exhibited by the images shown in Figure 2.

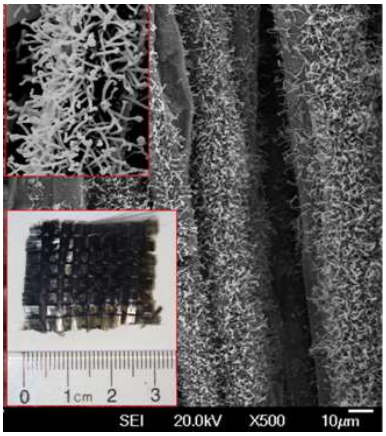


Figure 2. SEM image of the GFs, decorated by the as-grown CNTs, in the fabric (**Insets:** (top) zoomed-in view of the as-grown CNTs, (bottom) digital image of 1" × 1" CP coated GF fabric after the CNT growth process)

At higher magnifications, the nano/micro interface between the as-grown CNTs and GF can be clearly observed from Figure 2 top inset. The as-grown CNTs' coverage on the GF fabric surface seems to be very high, since the growth is observed to span along the full fiber axis. Both long-winding and short-rigid CNTs are grown in this forest, indicating the heterogeneous nature of the catalytic growth process induced by MW energy. Based on the measurements taken from the SEM image, the as-grown CNTs' average diameter is calculated to be ~50 nm, while their length could extend up to couple of microns. The as-grown CNTs' high aspect ratio thus provides ultra-high surface area, which both enables enhanced interfacial interactions and multi-scale functions for the FRPCS, through the formation of new interfaces. In addition, CNTs' characteristic matchstick-like morphology that is composed of hollow and graphitic multi-walled stem with oxidized Fe nanoparticle (NP) tip clearly indicates the effective tip-growth mechanism for their growth pattern, as well.

CONCLUSION

Hierarchically structured functional textiles with aligned nano/micro interface are prepared within very short time frames by applying MW energy based Poptube approach. Homogenously grown, forest-like CNTs were obtained on the CP coated GF fabric surface with high yield, high aspect ratio, and high coverage density. The as-produced functional textiles offer promising potential for FRPCSs preparation. The as-proposed highly efficient and cost-effective Poptube approach is also envisioned to secure the industrial scale production of such composites with high quality, as well.

REFERENCES

[1] GOJNY, F. H., WICHMANN, M. H. G., FIEDLER, B., BAUHOFER, W., SCHULTE, K. Influence of nano-modification on the mechanical and electrical properties of conventional fibre-reinforced composites, Composites Part a-Applied Science and Manufacturing, 2005, 36, 1525-1535.

[2] THOSTENSON, E. T., LI, W. Z., WANG, D. Z., REN, Z. F., CHOU, T. W. Carbon nanotube/carbon fiber hybrid multiscale composites, Journal of Applied Physics, 2002, 91, 6034-6037.

[3] MONIRUZZAMAN, M., WINEY, K. I. Polymer nanocomposites containing carbon nanotubes, Macromolecules, 2006, 39, 5194-5205.

[4] GARCIA, E. J., WARDLE, B. L., HART, A. J., YAMAMOTO, N. Fabrication and multifunctional properties of a hybrid laminate with aligned carbon nanotubes grown In Situ, Composites Science and Technology, 2008, 68, 2034-2041.

[5] ZHU, S., SU, C. H., LEHOCZKY, S. L., MUNTELE, I., ILA, D. Carbon nanotube growth on carbon fibers, Diamond and Related Materials, 2003, 12, 1825-1828.
[6] ZHANG, Q. H., LIU, J. W., SAGER, R., DAI, L. M., BAUR, J. Hierarchical composites of carbon nanotubes on carbon fiber: influence of growth condition on fiber tensile properties, Composites Science and Technology, 2009, 69, 594-601.
[7] PHILLIPS, J., LESEMAN, Z. C., CORDARO, J., LUHRS, C., AL-HAIK, M. Novel Graphitic Structures by Design, In: Proceedings of ASME IMECE, 2007, Seattle, WA, USA: 42977-42979.
[8] LIN, Y. R., EHLERT, G., SODANO, H. A. Increased Interface Strength in Carbon Fiber Composites through a ZnO Nanowire Interphase, Advanced Functional Materials, 2009, 19, 2654-2660.
[9] ZHANG, X. Y., MANOHAR, S. K. Microwave synthesis of nanocarbons from conducting polymers, Chemical Communications, 2006, 23, 2477-2479.
[10] LIU, Z., WANG, J. L., KUSHVAHA, V., POYRAZ, S., TIPPUR, H., PARK, S., KIM, M., LIU, Y., BAR, J., CHEN, H., ZHANG, X. Y. Poptube approach for ultrafast carbon nanotube growth, Chemical Communications, 2011, 47, 9912-9914.
[11] POYRAZ, S., LIU, Z., LIU, Y., ZHANG, X. Y. Devulcanization of Scrap Ground Tire Rubber and Successive Carbon Nanotube Growth by Microwave Irradiation, Current Organic Chemistry, 2013, 17, 2243-2248.
[12] LIU, Z., ZHANG, L., POYRAZ, S., SMITH, J., KUSHVAHA, V., TIPPUR, H., ZHANG, X. Y. An ultrafast microwave approach towards multicomponent and multi-dimensional nanomaterials, Rsc Advances, 2014, 4, 9308-9313.
[13] LIU, Z., CHEN, L., ZHANG, L., POYRAZ, S., GUO, Z. H., ZHANG, X. Y., ZHU, J. H. Ultrafast Cr(VI) removal from polluted water by microwave synthesized iron oxide submicron wires, Chemical Communications, 2014, 50, 8036-8039.
[14] XIE, H., POYRAZ, S., THU, M., LIU, Y., SNYDER, E. Y., SMITH, J. W., ZHANG, X. Y. Microwave-assisted fabrication of carbon nanotubes decorated polymeric nano-medical platforms for simultaneous drug delivery and magnetic resonance imaging, Rsc Advances, 2014, 4, 5649-5652.
[15] POYRAZ, S., ZHANG, L., SCHRODER, A., ZHANG, X. Y. Ultrafast Microwave Welding/Reinforcing Approach at the Interface of Thermoplastic Materials, ACS Applied Materials and Interfaces, 2015, 7, 22469-22477.
[16] ZHANG, X. Y., LIU, Z. Recent advances in microwave-initiated synthesis of nanocarbon materials, Nanoscale, 2012, 4, 707-714.

UTILIZING PTFE FILAMENT TO ACHIEVE EFFICIENCY AND AESTHETICS IN WEARABLE TRIBOELECTRIC GENERATORS

A. Repoulias[1], G. Ertekin[2], M. Ertekin[2], S. F. Galata[1], S. Mitilineos[1], S. Vassiliadis[1], A. Marmarali[2]

[1]*Department of Electrical and Electronics Engineering, University of West Attica, P. Ralli & Thivon 250, 12244 Athens, Greece*

[2]*Textile Engineering Department, Ege University, Bornova, Izmir, 35100, Turkey*

arepoulias@uniwa.gr

INTRODUCTION

One of the most interesting and unexplored physical phenomena which are met in the physical environment is that of triboelectricity. This describes the electrical energy that is produced when two material surfaces are brought in contact and separated. Most people might remember it from their childhood when rubbing a balloon on their head and then sticking it on the wall. However, triboelectricity today has been more than a game for many academic research teams worldwide. Over the last decade, big efforts have been applied to exploit it and produce sustainable electric energy through structures which are called triboelectric generators (TEGs) [1].

The suitable choice of the participating materials is very important in the direction of achieving the best electrical outputs of a TEG. And one of the most popular materials met very often in studies and reports is polytetrafluoroethylene (PTFE). A look at the various triboelectric series tables which classify materials according to their tendency to become positively or negatively charged after a contact, can quickly show that PTFE is always positioned at the very end of the tables, considered mainly the most negative one [2]. Considering that the higher the charge tendencies the more intense the phenomenon and the more efficient the TEGs, it becomes easily understood that PTFE is a big player in TEGs. Especially if taking into account its robust characteristics in resistance to wear and tear.

This paper presents the first steps which have been taken in an attempt to combine PTFE material and textile design. Until today, in triboelectric generators PTFE has been used as a film or coating, on either flexible or solid surfaces, using various methods. Hereby, thanks to the big opportunities of the textile technology, PTFE is used to build a knitted fabric which is after added in a testing TEG device to get examined.

MATERIALS AND METHODS

To build the sample fabric, PTFE filament (count 1250D) was supplied from Marmara Boyahanesi Company and used in a hand knitting machine of Ege University. The Milano-rib pattern was set and used for the sample production on a hand-knitting machine. After its production, the PTFE fabric was positioned on a prototype triboelectric generator measuring device designed and built in the University of West Attica [3]. This has been presented in previous studies and it can repeatedly bring in contact and rub the two under testing triboelectric surfaces. The testing conditions are such that the TEG measuring device can simulate a motion

as if the two triboelectric surfaces were positioned on a garment (e.g. on the inner side of the sleeve and aside from the body while walking).

RESULTS AND DISCUSSION

The produced peak-to-peak voltage (V_{pp}) which was measured on an oscilloscope upon the contact of the material surfaces, reached values from around 150 to 300mV. This is a significant amount of voltage taking into account the small participating fabric area (25cm^2) and the considerably low weight application (50grf) between the two surfaces. Practically, these voltage values can be increased by increasing the TEG's participating surface areas. That means that a garment, trouser or other clothing which provides sufficient fabric area can serve this role sufficiently if its surfaces are brought in contact and slightly rubbed (e.g. when walking, running etc).

Apart from the electrical outputs which were reached, the hereby presented knitted PTFE approach also covers the need for good aesthetics on clothing (e.g. garment, trouser etc) thanks to the option of uncountable knitting design potentials. As mentioned before, there are many examples in the bibliography about films and covers on solid or flexible surfaces to be used as TEGs, however, they mostly lack good aesthetics to be worn as a clothing part. This study, thanks to knitting suggests a better approach to reach both efficiency and aesthetics.

CONCLUSIONS

Numerous research articles refer to the use of PTFE material in triboelectric generators. However, they are mostly limited to use it as a film or a coating. Hereby, exploiting textile technology, PTFE filament was used to knit a sample fabric. This was paired with other samples to examine its triboelectric potentials as if it would be part of a wearable TEG. The electrical outcomes are significant, considering the size of the sample, providing a V_{pp} of 150-300mV. This work is summarized in the conclusion that textile technology can give significant solutions or suggestions to other technological areas like that of sustainable energy, overpassing its traditional applications, and achieving both efficiency and aesthetics.

Keywords: textile, knitting, PTFE, triboelectricity, triboelectric generator

ACKNOWLEDGEMENTS
The author would like to thank Mr. Mehmet Emre Kalpakli of Marmara Boyahanesi Company for his support in material supplies.

REFERENCES
1. LUO J, WANG ZL (2020) Recent progress of triboelectric nanogenerators: From fundamental theory to practical applications. EcoMat 2:. https://doi.org/10.1002/eom2.12059
2. GOKHOOL S, BAIRAGI S, KUMAR C, MULVIHILL DM (2023) Reflections on boosting wearable triboelectric nanogenerator performance via interface optimisation. Results in Engineering 17:100808. https://doi.org/10.1016/j.rineng.2022.100808
3. REPOULIAS A, ERTEKIN M, GALATA SF, PESEZ J, ANICAUX C, VASSILIADIS S, MARMARALI A (2023) The Effect of Ambient Humidity on the Performance of a Wearable Textile Triboelectric Generator. Energy Tech ente.202201433. https://doi.org/10.1002/ente.202201433

THE EFFECT OF USING GRAPHENE IN DENIM FABRICS ON THERMAL PERFORMANCE CHARACTERISTICS

Kübra Sabancı[1], Fatih Koyunoğlu[1], Cem Güneşoğlu[2]
[1] *Maritaş Denim San. Tic. Ve A:Ş / Aksu Mah. Kazancızade Sadi Bulv.Dulkadiroğlu/KAHRAMANMARAŞ*
[2] *Gaziantep University / Textile Engineering Department, GAZİANTEP*
ksabanci@maritasdenim.com

The use of graphene in textile surfaces resulted with advanced properties like enhanced electrical resistivity [1], hydrophobicity [2], thermal conductivity [3] and UV protection [4] which enabled to produce wearable e-textiles [5], adaptive optical textiles [6], textile-based temperature and pressure sensors [7,8]. Also, there are various studies on graphene utilization in clothing design for protective clothing, intelligent medical garments and adaptive clothing through IR emissivity. Thus, it is possible to produce graphene infused garments that regulate the body temperature.

This study investigates the thermoregulation performance of denim fabrics and to run objective measurements pointing it. For this purpose, commercially available graphene / PET blend yarns were used as weft in denim fabric (graphene denim) and thermal performance assessments comparing with conventional %100 cotton denim fabric (conventional denim) were completed by an in-house method based on thermal camera imaging along with objective thermal diffusivity, thermal absorbtivity and maximum heat flux measurements. The in-house method was used to calculate so-called "dissipation delta value" which showed better thermal distribution on graphene denim. Also, graphene denim exhibited higher maximum heat flux as expected due to increased thermal conductivity, however it gave lower thermal absorptivity and increased thermal diffusivity. This finding agrees with some earlier studies on graphene [9] and calculated dissipation delta value. Graphene denim sample was found to have lower thermal capacity which is correlated with better thermo-response or thermoregulation.

Keywords: Graphene, denim, thermal diffusivity

REFERENCES

[1] KONGAHGE, D. et al. Fabrication of a graphene coated nonwoven textile for industrial applications. RSC Advances, 2016, vol.77, no.6, pp 73203-73209.
[2] TISSERA, N.D. et al. Hydrophobic cotton textile surfaces using an amphiphilic graphene oxide (GO) coating. Applied Surface Science, 2015, vol.324, pp 455-463.
[3] MANASOGLU, G. et al. Electrical resistivity and thermal conductivity properties of graphene-coated woven fabrics. Journal of Applied Polymer Science, 2019, vol.136, no.40, pp 48024-48032.
[4] OUADIL, B. et al. Surface modification of knit polyester fabric for mechanical, electrical and UV protection properties by coating with graphene oxide, graphene and graphene/silver nanocomposites. Applied Surface Science, 2017, vol. 414, pp 292-302.
[5] KARIM, N. et al. Scalable production of graphene-based wearable e-textiles. ACS Nano, 2017, vol.11, no.12, pp 12266-12275.
[6] ALONSO T. et al. Graphene electronic fibres with touch-sensing and light-emitting functionalities for smart textiles. NPJ Flexible Electronics 2018, volç2, no.25, pp 1-8.

[7] SADASIVUNI, K.K. et al. Reduced graphene oxide filled cellulose films for flexible temperature sensor application. Synthetic Metals, 2015, vol.206, pp 154-161.
[8] ZHU S.E. et al. Graphene based piezoresistive pressure sensor. Applied Physics Letters, 2013, vol.102, pp 161904-161912.
[9] EL-BROLOSSY, T.A., ALMUTAWA, A., Thermal diffusivity and thermal effusivity enhancement of graphene based polyvinyl chloride nanocomposites. IOP Conference Series: Materials Science and Engineering, 202, vol.762, pp 0122006-0122017.

IMPLEMENTATION OF MODERN DYNAMIC APPROACH IN GARMENT PATTERN DESIGN FOR DEAF PEOPLE

Nataliya Sadretdinova[1,2], **Yordan Kyosev**[2], **Maryna Yatcenko**[1]
[1]*Kyiv National University of Technologies and Design*
[2]*Dresden Technical University*
natalija.sadretdinova@mailbox.tu-dresden.de

According to the World Health Organisation, more than 5% of the world's population, or 430 million people, need rehabilitation to address their hearing loss. It is estimated that by 2050, more than 700 million people - or one in ten - will have a disability-related hearing loss. To set the stage for physical and social rehabilitation, the use of adaptive clothing is important.
Although it is generally believed that hearing impaired people do not have special requirements for their clothing, the analysis of the specific needs of this community shows otherwise. Active manual articulation in sign language communication causes strain on the arms and back, which is significantly increased by uncomfortable clothing. This can be especially true for sign language interpreters, for whom one work cycle can last up to 4 hours. Therefore, our topic relates to the development of adaptive clothing with high wearing comfort for individuals who use sign language in their everyday life based on the latest technical solutions in the field of clothing design.
All current research in this direction is related to the improvement of communicative abilities in one form or another. In the clothing market, some brands offer customisation of clothing for hearing impaired people through colour design or printed information images [1]. Another trend is the use of built-in electronic elements that can reinforce sound or simulate acoustic recording [2]. At the same time, no research on improving the wear comfort of garments for sign language spiking persons was found in the available sources.
Providing the dynamic adaptability of clothing is based on the study of typical movements that are relevant to a given functional environment. For the analysis of sign language movements, a new methodology was developed with the participation of the co-authors [3]. The typical shoulder and arm movements that determine the majority of sign language gestures were recorded using the modern 4D scanner. By further processing the scan data, an avatar with a constant mesh was mapped. Using this homologous mesh, any part of the body can be analysed over a movement. For this purpose, specific marks on the body were identified, projected on the mesh, and defined in a 3D coordinate system. In order to analyse and systematise the movements, the analysis of the relative displacements of the individual vertices was carried out in Matlab [4]. This made it possible to determine the extreme positions of the individual segments of the kinematic model in the 3D coordinate system, measure the corresponding lengths and analyse the dynamic changes (Fig. 1).
The CAD Systhem GRAFIS for the construction of clothing/footwear and technical textiles (www.grafis.com) was used for the development of the garment pattern. The algorithm-based method also enables the implementation of individually adjustable constructions. The creation of construction-related functional parameters or allowances (e.g. dynamic allowances) is also possible via the parameters, which allows additional modelling if that is necessary.
Due to the mentioned advantages of the GRAFIS-software, the garment pattern was developed taking into account the dynamic measurements required to ensure the ergonomics during sign language typically movements. Most of the parametric changes concern the width of the back and front parts, the width and length of the sleeves, and the dimensions of the dart, which causes further deformations of the armhole and the sleeve cap. It is obvious that ensuring ergonomic

in a constructive way will lead to a complete deformation of the product shape and occurs fitting defects in the product.

In the final phase of the work, the designed garment was simulated on a virtual figure using application software. In doing so, certain movement traces of the sign language and material properties could be taken into account. In order to have realistic results, movements recorded with a 4D scanner were imported into the 3D workspace. Afterwards, the previously created pattern construction was virtually sewn in three dimensions on the processed scan data set. This allowed the problem areas to be determined, which should be taken into account in the pattern design process due to the lack of fit.

The obtained results indicate that it is not possible to achieve the desired ergonomics of the product through dynamic allowances alone. In addition, an excessive increase in certain construction parameters leads to deformation in the overall shape of the garment, which negatively affects the aesthetic component and makes the product unacceptable for use. Therefore, it is necessary to provide the best option for compensating dynamic increases by cooperating with dynamic allowances and material properties. The interaction between material elasticity and the value of dynamic allowances on the stress value in developed and virtually simulated jacket was investigated. Regression analysis was applied to determine the optimum values, which were used to optimise the construction.

The used approach allowed establishing optimal initial parameters to develop an ergonomic jacket design for people who use sign language to communicate, including formal ones.

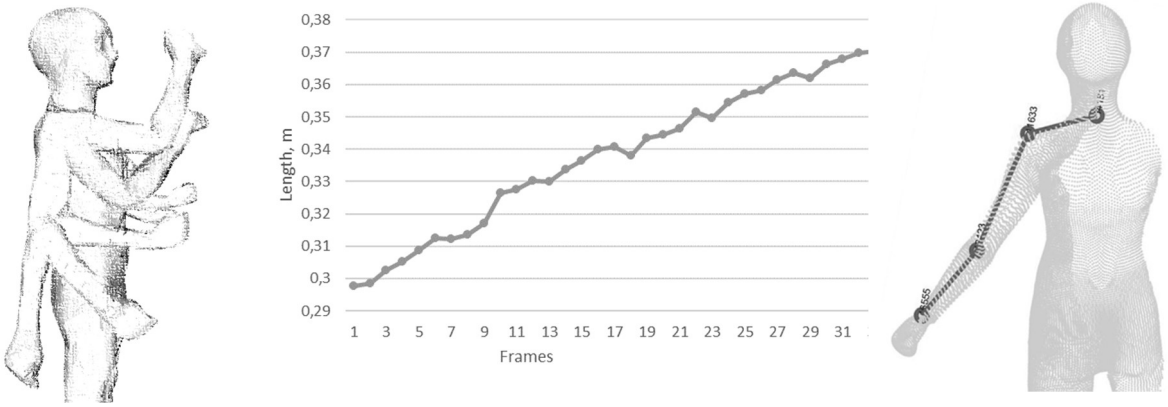


Figure 1. Change the position and length of selected segments in motion

Keywords: dynamic measurement, 4D scanning, sign language, clothing for Deafs

[1]. Inside deaf. Apparel / Deaf Apparel // https://www.deaf-apparel.com/ (Accessed 2020)

[2]. The sound shirt lets deaf people feel music on their skin / designboom // https://www.designboom.com/technology/cute-circuit-deaf-people-feel-music-skin-soundshirt-haptic-sensors-10-04-2019/ (Accessed 2022)

[3]. KYOSEV, Y. et al.: Method for Automatic Analysis of the Clothing Related Body Dimension Changes During Motion Using High-Speed (4D) Body Scanning. In: Proc. of 3DBODY.TECH 2022 - 13th Int. Conf. and Exh. on 3D Body Scanning and Processing Technologies, Lugano, Switzerland, 25-26 Oct. 2022, #24, https://doi.org/10.15221/22.24

[4]. SADRETDINOVA, N.; KYOSEV, Y. Method for Evaluation of the Motion Comfort of the Clothing for Deaf People Using of High Speed (4D) Scanning. In: Proc. of 3DBODY.TECH 2022 - 13th Int. Conf. and Exh. on 3D Body Scanning and Processing Technologies, Lugano, Switzerland, 25-26 Oct. 2022, #60, https://doi.org/10.15221/22.60.

DEVELOPMENT OF A PRODUCTION SYSTEM FOR BLEACHING MACHINES INDEPENDENT OF HUMAN CONTROL AND AIMING THE RIGHT PRODUCTION AT ONCE

Gökçe Sakmar[1], Murat Yıldırım[1], Gizem Özbek Çam[1], Fatih Halimoğlu[2], Mehmet Bilgi[2]
[1] *Zorluteks Textile Trade and Industry Inc./ R&D Department /Kırklareli,Turkey*
[2]*Hubbox Industrial Technology Software and Consulting Industry. Trade Inc./ İstanbul, Turkey*
gökce.sakmar@zorlu.com

Industry 4.0, which is stated with terminologies such as Digital Transformation, Digitizing Industry, and Fourth Industry Evolution, is a collective term that encompasses automation systems, data interchange, and production technologies, where business activities are handled with data-based scientific methodologies. Industry 4.0 generally starts with the purchase of raw materials, producing products, delivering them to the consumer, and then recycling, deterioration, etc. It alludes to the continued use of emerging technologies to improve processes at all points along the supply chain, including the recall of reasons [1]. Industry 4.0 applications offer considerable improvements in terms of production efficiency, product quality, resource, time, and energy savings, and are now widely used across a variety of industries. Speed, width-depth, and system effect are three of Industry 4.0's most significant defining characteristics. The competition between businesses and nations is made up of these three defining characteristics. As a result of this conflict, it is expected that enterprises and countries that do not comply with these three aspects would suffer large losses in the coming periods [2].

It becomes clear that the textile industry was the primary sector at the outset of the industrialization revolution in many developed nations. As a consequence of the studies, it is determined that integrating Industry 4.0 into the textile business has numerous advantages, including improved efficiency, decreased operating costs, improved quality, transparency, sped-up order delivery, and enhanced customer satisfaction [3]. Due to the challenges faced in the production of the textile industry, it is expected in a different study done in Germany that Industry 4.0 would be in a better position thanks to the manufacturers of system software and current machinery in the textile sector [4].

Yosumaz et al. in their study, make sure that various parameters, including employee performance information, machine capacity information, machine fault conditions information, machine temperature and vibration information, and machine usability status are tracked with Industry 4.0 applications integrated into the production processes of the ready-made clothing company [5]. In a different study by Gökalp et al., studies were done into the development of a smart clothing factory in the ready-made clothes sector, and Industry 4.0 applications were recommended for the process from the acquisition of raw materials through the packing and delivery of the product to the customer [3].

As a result of this research, it is predicted that many processes in the textile industry can be included in Industry 4.0 applications. There are many error-prone processes in the textile industry. One of these is bleaching, which is the removal of the color of raw textiles by removing natural pigments. Thanks to the bleaching process, a constant whiteness value is obtained in the fabrics and thus color problems that may be encountered in the subsequent processes are avoided. There are multiple dependent and independent variables in this process. Making these variables manually by the operator makes this process an error-prone process.

This study's goal is to develop a smart factory based on preventing human-induced errors in the machine parameter settings for the fabric type in the bleaching machine. The goal of integrating Industry 4.0 into the production system is to move the decision-making process to the system by focusing on machine adjustment. The system will become error-proof in this way, and potential issues will be resolved. As a result, it aims to standardize production, prevent quality-related issues by producing the proper amount at once, and utilize resources as efficiently as possible.

Within the scope of the study, first of all, machine parameters were examined. In this context, the parameters set by the operator are divided into variable and fixed parameters. Fixed parameters are the settings made for the machine to continue working in a healthy way regardless of the fabric type, variable parameters are the fabric type, fabric width, etc. including settings such as. As a result of the studies, a detailed library of machine adjustment systems has been prepared. These process parameters are followed and the process information is transferred to the SCADA environment with the PLCs on the machines. This transfer process is shown in Figure 1.

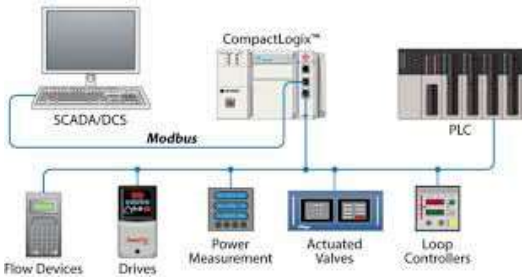


Figure 1. SCADA and PLC systems

In the project study, a program that can operate in MASTER and SLAVE modes has been created. Within the parameters of the study, a system known as Industry 4.0 was created that can automatically set the machine's settings in accordance with the type of fabric being used. Thanks to the designed technology, the machine reads the fabric ID card before beginning the fabric production and then automatically performs the necessary adjustments in accordance with the kind of fabric. As a result, the production system was upgraded to include the developed Industry 4.0 application, and the decision-making process for machine adjustment was moved from humans to the system.

Keywords: Industry 4.0, Digitalizing, Home Textile Production Steps

Our studies have been supported by TUBITAK with project number 3215063 within the scope of 1707 TEYDEB.

[1]MUTLU, M., Perceptions of Industry 4.0 applications: A research on the automotive and textile sectors, Bursa Uludag Unıversity Institute of Social Sciences, Master’s degree Thesis, 2019.
[2]ÖZSOYLU, A., F., Industry 4.0. Journal of Cukurova University Faculty of Economics and Administrative Sciences, Volume: 21, Issue: 1, 41-64.

[3]GÖKALP, E., GÖKALP, M., O., EREN, P., E., Industry 4.0 Revolution In the Apparel Sector: Smart Apparel Factory AHIT-e: Academic Journal of Information Technology, 10(37), 73-96. Doi: 10.5824/1309-1581.2019.2.005.x
[4] İLHAN, İ., Concept of industry 4.0 in textile manufacturing processes, Pamukkale University Journal of Engineering Sciences, 25(7), 810-823,2019. Doi: 10.5505/pages.2018.69851
[5] YOSUMAZ, B., ÖZKARA, B., Effects of Industry 4.0 Process on Garment Businesses: The Case Study of Hugo Boss Turkey, Journal of Business Research- Turk, 2019, 11(4), 2587-2600. http://doi.org/10.20491/isarder.2019.760

SUSTAINABLE DYEING PROCESS OF PET FABRICS BY USING IONIC LIQUIDS

Dilara Sevindik[1], Aysun Akşit[2], Serap Seyhan Bozkurt[3], Duygu Totur Pamik[4], Şafak Birol[5]

[1] Dokuz Eylül University / Graduate School of Natural and Applied Sciences / Tınaztepe Campus, Buca, İzmir 35160, Turkey
[2] Dokuz Eylül University / Department of Textile Engineering / Tinaztepe Campus, Buca, İzmir, 35390, Turkey
[3] Dokuz Eylül University / Department of Chemistry / Tinaztepe Campus, Buca, İzmir,35390, Turkey
[4] Dokuz Eylül University / Department of Environmental Engineering / Tinaztepe Campus, Buca, İzmir, 35390, Turkey
[5]TYH Textile/ R&D Center / Işıkkent, İzmir, 35070, Turkey
dilarademirtas26@gmail.com

PET fiber is most widely used synthetic fiber because of the fact that good elastic recovery, ease of care, long life, excellent dimensional stability, resistance to many chemicals and high tensile strength. However, the high degree of crystallinity, lack of active groups and hydrophobic characteristic lead to difficulties for penetration of dye molecules into the fiber [1]. Therefore, PET fabric needs to be dyed with carrier method or high temperature (HT) dyeing method at around 130°C. These methods provide better disperse dye penetration into the fiber matrix and can be achieved higher colour yield [2, 3]. However, HT dyeing method comes up with two drawbacks, high energy consumption and long dyeing duration. In recent years, researches on alternative PET dyeing method at low temperature has increasingly drawn attention within the sustainable production goals [1]. In this regard, one of the most effective alternative approaches that may be used in the PET dyeing process is the utilization of ionic liquid as an auxiliary chemical or solvent under atmospheric dyeing conditions. [4, 5, 6].

Ionic liquids are novel green solvents with melting points below 100°C that may be made up of millions of different cation and anion combinations. The selection of cation and anion influences the key features of ionic liquids for dyeing, such as density and viscosity. This liquid class also has numerous properties that allow them to be considered sustainable chemicals, including high thermal stability, good recycling, mild reaction conditions, non-volatility, non-flammability, reusable, waste prevention and low toxicity [6, 7].

This research is mainly focused on minimizing energy and chemical demand in PET dyeing with the utilization of mono and dicationic ionic liquids in textile dyeing process.

%100 PET knitted fabric (120 g/m^2, single jersey) and C.I. Disperse Red 167 were used in the textile dyeing process. 1-butyl-3-methylimidazolium chloride (IL1), 1-butyl-3-methylimidazolium bromide (IL2), 1,4 bis(3-methylimidazolium) butane dibromide (IL3), 1,4 bis(3-methylimidazolium) butane dichloride (IL 4) have been synthesized by Dokuz Eylül University Department of Chemistry for IL dyeing processes. Dyeing experiments were carried out with 0.5% and 2% disperse dyestuff, 1:20 liquor ratio at 95°C,130°C according to exhaust dyeing method. In blind dyeing, only dyestuff and water were used to observe the effects of ionic liquids. IL has been utilized as a solvent and an auxiliary chemical in our eco-friendly dyeing processes. When ionic liquid has been used as an auxiliary chemical, 2g/l-5g/l-10g/l-20g/l (ionic liquid/water-(w/v)) solutions are prepared, and the dyestuff dissolves in these

solutions. In case of IL usage as a dyeing medium, the dyestuff is dissolved directly in the ionic liquid. All experiments carried out at pH 4.

Washing and rubbing fastness, UV-VIS spectroscopy, XRD, and FTIR analyses has been performed after ionic liquid and conventional dyeing methods to examine the influence of ionic liquids on PET dyeing properties. The colour strength (K/S values) of PET fabrics dyed at 95°C was determined by using Minolta 3600d spectrophotometer. The results are given in Table 1.

Table 1. 95°C Dyeing results (0.5% dyestuff)

	K/S Values (95°C)
Blind dyeing (Water and dyestuff)	3.0916
IL 1 (5g/l)	4.6091
IL 2 (5 g/l)	4.3364
IL 3 (5g/l)	5.3396
IL 4 (5 g/l)	5.1253

Table 1 shows that colour strength of IL dyeing samples higher than the blind dyeing samples. Utilizing IL in dyebath can improve dyeing properties at low temperature by reducing the crystallinity of the fiber's molecular structure [5]. Furthermore, the remaining dyebath solution visually demonstrates that ionic liquids increase dye uptake as compared to blind dyeing at 95°C.

Keywords: Sustainable dyeing of PET, ionic liquids, 1-butyl-3-methylimidazolium bromide, 1,4-bis(3-methylimidazolium) dibromide, 1-butyl-3-methylimidazolium chloride.

This study is supported by TÜBİTAK 2244 with the project number 119C078 and Dokuz Eylül University BAP with the project number 2732.

[1] WANG, X., WANG, J., HE, J., GU, X., QIN, K. A comparative study on dyeing properties of iterative polyester and ordinary polyester dyed with disperse dyes. The Journal of The Textile Institute, 2023, 114, 5, 774-781.
[2] NAKPATHOM, M., SOMBOON, B., NARUMOL, N., MONGKHOLRATTANASIT, R. High temperature dyeing of PET fabric with natural colourants extracted from annatto seeds. Pigment & Resin Technology, 2019, 48, 2, 129-136.
[3] OPWIS, K., GUTMANN, J. S., and KNITTEL, D. Dyeing of textile materials in ionic liquids. In 5th International Congress on Ionic Liquids (COIL-5). Vilamoura, Portugal. 2013.
[4] OPWIS, K., BENKEN, R., KNITTEL, D., GUTMANN, J. S. Dyeing of PET fibers in ionic liquids. International Journal of New Technology and Research, 2017, 3, 11, 101-108.
[5] BIANCHINI, R., CEVASCO, G., CHIAPPE, C., POMELLI, C. S., RODRÍGUEZ DOUTON, M. J. Ionic liquids can significantly improve textile dyeing: an innovative application assuring economic and environmental benefits. ACS Sustainable Chemistry & Engineering, 2015, 3, 9, 2303-2308.
[6] MEKSI, N., MOUSSA, A. A review of progress in the ecological application of ionic liquids in textile processes. Journal of Cleaner Production, 2017, 161, 105-126.
[7] TROGER-MULLER, S., BRANDT, J., ANTONIETTI, M., LIEDEL, C. Green Imidazolium Ionics–From Truly Sustainable Reagents to Highly Functional Ionic Liquids. Chemistry–A European Journal, 2017, 23, 49, 11810-11817.

A RESEARCH ON PROPERTIES OF KNITTED FABRICS PRODUCED WITH RING AND ROTOR-SPUN YARNS CONTAINING RECYCLED COTTON FIBER

Çağla Deniz Şentürk[1,2], **Tuba Bedez Üte**[3]
[1] *Ege University Graduate School of Natural and Applied Sciences / Izmir*
[2] *SANKO Textile and Trading Corporation/ Gaziantep*
[3] *Ege University, Textile Engineering Department / İzmir*
cagla.senturk@sanko.com.tr

Like other industries, textile industry needs to be flexible and suitable for all human demands due to decreasing resources and increasing human population and desires. Therefore, textile has found internal source as "recycling materials" or "waste management". Technologies for reintroducing recycled fabrics into production have existed for a long time, textile recycling has only started to gain more awareness and popularity in the last decade compared to past. So that, all manufacturers has started searching for new ideas and technologies to settle the suitable and valuable production to their influence. Developments has been done with different raw materials, compositions to achieve similar quality to conventional qualities.

Recycling is the process of converting materials from all kinds of waste to produce new products. Textile recycling implies the reuse and reprocessing of clothing scraps or any fibrous textile material. All types of consumer or industry discarded textile goods are used as textile wastes for recovery. It is obvious that recycling, which has evolved into sustainability over time and its importance has been understood even in ancient times. Recycling can be defined as re-producing all kinds of materials into similar or different products and can be classified as “open-loop” and “close-loop recycling”. It can be applied in many fields of the textiles as textile-to-textile (closed-loop) recycling or textile-to-nontextile (open-loop) recycling (1).

Textile recycling wastes can be divided as pre-consumer and post-consumer wastes. Pre-consumer wastes which are generally came out during production, could be fiber, material or uncomplicated materials of production which will never meet with customer. Post-consumer materials are wastes comes from customers used garments. The textile recycling route can be classified based on the nature of the processes involved or the level of disassembly of the recovered materials. Fabric recycling consists in recovering and reusing of a fabric into new products (2). Integration of recycling may be challenging for couple of reasons such as separating wastes between each other, pre-treatment planning, sustainability concerns and rules. Researchers focused on recycling parameters and the utilization of recycled cotton fibres for different purposes. Lu et al. (2023) compared the characteristics of waste cotton and high-value products such as yarn, composites, regenerated cellulose fibers, biofuels etc. derived from waste cotton via mechanical, chemical, and biological recycling methods. They’ve concluded that as low-cost cotton and high return values can be obtained with recycling waste cotton, industrialization and commercialization can be achieved. The spatial water footprint of a 100% cotton T-shirt was investigated and compared different recycling scenarios like no recycling, 30% recycling, and 100% recycling were compared [4]. Bogale et al. (2023), focused on acoustics insulation properties of samples made from recycled Cotton/polyester (PET) in different blend ratios and found that recycled/PET/cotton selvedge waste showed more than 70% of the sound absorption coefficient and the recycled nonwoven mats provided the best insulation, sound absorption, moisture absorption, and fiber properties. Özdil et al. (2023), developed functional and high value-added upholstery fabrics by recycled cotton/polyester blended yarns with different ratios. They’ve reported that fabrics containing 15% recycled

cotton showed better results among the other flame retardant, water, and stain repellent upholstery fabrics. A new type of vacuum insulation panels with recycled and economical cotton fiber core was prepared by Kan et al [7]. Ütebay et al. (2019), reported that the recycled fibre quality and the yarn properties are associated with the waste fabric properties and shredding parameters. They've showed that the yarns produced from greige fabric based recycled fibres had higher tenacity and lower hairiness. Higher quality recycled cotton fibres can be achieved by the selection of loosely knitted greige cotton fabrics shredded in 3 passages with large feeding size. In their further study, 30 tex and 20 tex, 100% cotton yarns were produced with different recycled/virgin fiber blend ratios (with a recycled fiber ratio more than 50%) by compact and open-end spinning systems without any chemicals treatment. They've found that yarn properties improved with the increase of virgin cotton fiber ratio in the yarn. The yarn hairiness and unevenness of open-end yarns were better whereas yarn tenacity is lower compared to compact-spun yarns [9].

This study was conducted on the production of value added products like finer yarns from recycled cotton fibers obtained from pre-consumer textile products with acceptable quality and high recycled fiber ratios. With the aim of investigating the effects of yarn count, spinning system and an excessive amount of recycled cotton fiber content; recycled cotton and virgin cotton fibers were blended in different blend ratios. Recycled cotton fiber is expressed as Re-Co and virgin cotton fiber as V-Co. The Re-Co used in the study was obtained from post-consumer textile products. Ring and rotor spun yarns were spun in different yarn counts (Ne 18, Ne 24 and Ne30) by using 100% cotton fibres (containing Re-Co and V-Co) and single jersey fabrics were knitted from these yarns. Yarn (yarn evenness, hairiness, breaking strength) and fabric (Martindale pilling test after 2000 cycles and bursting strength) properties were measured. Yarn strength results and Cv% of the results are given in Figure 1.

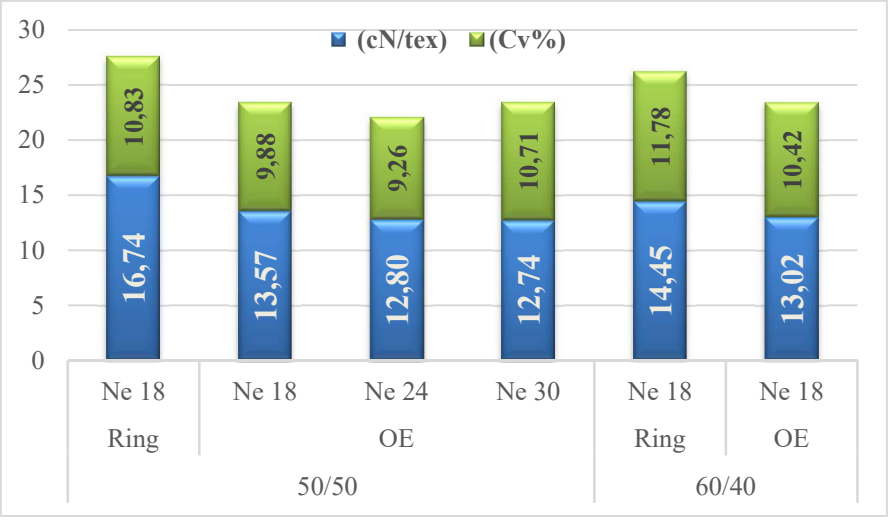


Figure 1. Yarn tenacity test results. (cN/tex).

According to Figure 1, yarn strength variation increased with the decrease of yarn count (Ne) and virgin cotton ratio in the blend. It is found that rotor spun yarns' offer a more stable structure in terms of yarn tenacity. Regarding spinning system, ring-spun yarns had higher yarn evenness, yarn hairiness and yarn tenacity values, compared to rotor-spun yarns with the same blend ratio and yarn count. Among rotor-spun yarns produced with 50/50 Re-Co /V-Co fibers, finer yarns had higher yarn evenness, lower yarn hairiness and yarn strength values. Single jersey fabrics

produced with ring spun yarns containing Re-Co showed higher bursting strength and lower pilling tendency, regardless of the Re-Co ratio in the blend.

Keywords: recycled cotton, spinning, knitted fabric, sustainability, virgin cotton.

REFERENCES

[1] Ekolojist, Tekstil Geri Dönüşümü Nasıl Yapılır? [cited 01.06.2023]. Available on https://ekolojist.net/tekstil-geri-donusumu-nasil-yapilir
[2] Geri Dönüşüm Kumaş Rehberi, Atilla Tekstil, [01.06.2023]. Available on https://atillatekstil.com/tekstil-bilgilendirme-atolyesi/geri-donusum-kumas/
[3] LU, Linlin, et al. Current recycling strategies and high-value utilization of waste cotton. Science of The Total Environment, 2023, 856: 158798.
[4] CHEN, Shuang, et al. A Spatial Water Footprint Assessment of Recycled Cotton T-Shirts: Case of Local Impacts in Selected China Provinces. Sustainability, 2023, 15.1: 817.
[5] BOGALE, Meseret, et al. Sound absorbing and thermal insulating properties of recycled cotton/polyester selvedge waste chemical bonded nonwovens. The Journal of The Textile Institute, 2023, 114.1: 134-141.
[6] ÖZDIL, Nilgün, et al. Multifunctional Modification with TiO2, SiO2, and Flame Retardant Agent on Upholstery Fabrics Produced From Recycled Cotton Fibers. AATCC Journal of Research, 2023, 24723444221147976.
[7] KAN, Ankang, et al. Effective thermal conductivity of vacuum insulation panels prepared with recyclable fibrous cotton core. International Journal of Thermal Sciences, 2023, 187: 108176.
[8] ÜTEBAY, Burçin et al. Effects of cotton textile waste properties on recycled fibre quality. Journal of Cleaner Production, 2019. 222, 29-35.
[9] UTEBAY, Burcin et al. Valorization of fabric wastes through production of recycled cotton yarns by compact ring and open-end rotor spinning. Journal of Cleaner Production, 2023, 409: 137135.
[10] JOHNSON, Sara, et al. Supply chain of waste cotton recycling and reuse: A review. AATCC Journal of Research, 2020, 7.1_suppl: 19-31.

THE EFFECT OF DIFFERENT STRUCTURAL PARAMETERS AND WASHINGS ON THERMAL PROPERTIES OF DENIM FABRICS

Esra Taştan Özkan[1], Binnaz Kaplangiray[2], Ceren Başak Bozeli[3], Yasemin Sener[2]
[1] *Bitlis Eren University /Traditional Turkish Arts / Bitlis Turkey*
[2] *Bursa Uludag University / Textile Engineering / Bursa Turkey*
[3] *Iskur Denim/Kahramanmaraş/ Turkey*
etastan@beu.edu.tr

Denim fabrics are durable and abrasion resistant fabric structures that have been developed as workwear in previous times. Denim fabrics are woven using 2/1 and 3/1 Z twills, which are generally warp-faced twill types. The warp thread is indigo blue dyed, and the weft thread consists of raw and undyed cotton threads. The parameters that affect thermal comfort are thermal resistance, thermal conductivity, air permeability, and water vapour permeability. Because denim fabrics are in a hard structure after weaving, the appearance and comfort properties of denim fabrics are changed by washing such as bleach, stone, enzyme and rinse. Vivekanadan et al. (2011) investigated the warm-cool feeling of denim fabrics and declared that the washing process creates a feeling of coolness. In a study investigating the impact of fabric structural properties on the thermal and air permeability features of denim fabrics, it was found that properties such as the fiber type, yarn structure and fabric thickness affect the thermal comfort of denim fabrics (Khushbu et al. 2015). Mangat et al. (2012), investigated the effect of different weft yarn and washing treatments on moisture management properties of denim fabrics. It was found that the overall moisture management values of the denim fabrics were affected by the washing treatments and weft yarns. In another study, the influence of different softeners on the thermal and comfort features of stretch denim fabrics were investigated. The results demonstrated that the water vapour permeability values were higher when non-ionic softeners were used than when both enzyme and stone enzyme washing were used (Hosen et al., 2021). The thermophysiological comfort properties of different washed cotton denim fabrics have been investigated in a previous study. It was found that the comfort properties of denim fabrics are influenced by their weight and thickness (Eryürük, 2021). Türksoy et al. (2021) investigated the effects of the weft yarn type, weft density and finishing process on the elasticity, permanent elongation, thickness, thermal resistance, water vapour permeability and air permeability properties of different denim fabrics. It was observed that the weft yarn type, weft density, and finishing process had statistically significant effects on the comfort properties of denim fabrics.

The aim of this study was to investigate the effects of different weft yarns, twill directions, and different washing processes on the thermal properties of denim fabrics. The properties of the tested samples are presented in Table 1. The thermal resistance, thermal conductivity and thermal diffusion coefficient of the denim fabrics were measured with the Alambeta test device. The results showed that the highest thermal resistance values were observed for the rinse washed fabrics, and the lowest thermal resistance values were observed for the enzyme washed fabrics. The highest thermal conductivity values were observed for fabrics in cotton/modal elastane weft yarn woven fabrics in the Z- twill direction. In addition, the twill direction only affects the thermal conductivity of fabrics and Z-twill direction fabrics have higher thermal conductivity values. The lowest thermal conductivity values were observed for rinse washed fabrics, and the highest thermal conductivity values were observed for stone washed fabrics. The lowest thermal diffusion coefficients were measured rinse washed fabrics and the highest thermal diffusion coefficients were measured in bleach washed fabrics (except MSB).

Table 1. Properties of denim fabrics

Fabric Type	Warp Yarn Count (Ne)	Weft Yarn Count (Ne)	Composition	Weight
PZB	9.97	16	%100 Cotton+ 78 Dtex Elastane	405
PZE	9.97	16	%100 Cotton+ 78 Dtex Elastane	396
PZR	9.97	16	%100 Cotton+ 78 Dtex Elastane	396
PZS	9.97	16	%100 Cotton+ 78 Dtex Elastane	408
PSB	9.97	16	%100 Cotton+ 78 Dtex Elastane	393
PSE	9.97	16	%100 Cotton+ 78 Dtex Elastane	388
PSR	9.97	16	%100 Cotton+ 78 Dtex Elastane	387
PSS	9.97	16	%100 Cotton+ 78 Dtex Elastane	396
MZB	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	415
MZE	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	412
MZR	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	411
MZS	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	419
MSB	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	401
MSE	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	407
MSR	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	402
MSS	9.97	16	%85 Cotton+ %15 Modal + 78 Dtex Elastane	406
TZB	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	410
TZE	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	412
TZR	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	411
TZS	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	418
TSB	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	403
TSE	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	376
TSR	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	397
TSS	9.97	16	%85 Cotton+ %15 Tencel + 78 Dtex Elastane	403

*B= bleach washing, E=enzyme washing, R= rinse washing, SE=stone+enzyme washing, Z= twill direction Z and S= twill direction S.

Keywords: denim, different washings, thermal properties, Tencel, Modal**.**

ACKNOWLEDGEMENT

This work supported by TÜBİTAK 1505 - University-Industry Cooperation Support Program with ISKUR Denim Kahramanmaraş and Uludag University partnership (Project number 5210060).

REFERENCES

[1] VIVEKANADAN, M.V., RAJ, S., SREENIVASAN, S., NACHANE, R.P. Parameters affecting warm-cool feeling cotton denim fabrics. Indian Journal of Fibre & Textile Research, 2011, Vol. 36, pp 117-121.

[2] KHUSHBU, P., THAKKAR, A. Effect of Fabric Construction Parameters on Air Permeability and Thermal Resistance of Commercially Produced Denim Fabric. International Journal for Scientific Research & Development, 2015, Vol. 3, pp 767-769.

[3] MANGAT, M.M., HUSSAIN, T., BAJZIK, V. Impact of Different Weft Materials and Washing Treatments on Moisture Management Characteristics of Denim. Journal of Engineered Fibers and Fabrics, 2012, Vol. 7, No. 1, pp 38-49.

[4] HOSEN F., ASIF A.H., HASAN Z, MAHMUD S.T., ISLAM R. Evaluation of comfort and thermal properties of stretch denim fabric by applying different softeners. Indian Journal of Science and Technology, 2021, Vol. 14, pp 752–764.

[5] ERYÜRÜK, S.H. Analyzing thermophysiological comfort and moisture management behavior of cotton denim fabrics. AUTEX Research Journal, 2021, Vol. 21, No 2, pp 248-254.

[6] TÜRKSOY, H.G., YILDIRIM, N., AVCI, M.E. Comparative evaluation of some comfort properties of denim fabrics including dual-core yarns containing wool and elastane yarn. The Journal of The Textile Institute, 2021, pp 1-8.

THE EFFECT OF PCM ON THE SURFACE TEMPERATURE OF TIGHT GARMENTS AND SUBJECTIVE COMFORT EVALUATIONS

Esra Taştan Özkan[1], Binnaz Kaplangiray[2], Dilek Kut[2], Nur Berat Bayır[2]
[1] *Bitlis Eren University /Traditional Turkish Arts / Bitlis Turkey*
[2] *Bursa Uludag University / Textile Engineering / Bursa Turkey*
etastan@beu.edu.tr

Thermal comfort of human change with the metabolic rate (internal heat production), heat loss from the body, and climatic conditions. The main task of clothes is to ensure the continuity of the thermal balance by balancing the heat and moisture losses on the skin surface. Phase change materials (PCM) provide storage at a constant temperature range and can be used for both heating and cooling depending on the melting temperature [1]. PCM has a very high ability to store high levels of energy during melting or solidification, and it has a structure that can release the stored energy [2]. PCMs are generally used by encapsulating very small microspheres. Today, phase change materials in textiles are mainly designed to produce temperature-regulating products to achieve improved thermal comfort [3]. The parameters that are important for microcapsules are the diameter of the capsule, the thinness of the capsule shell, its heat conduction property, and its adaptation to volumetric changes [4]. The microcapsule with PCM should control the heat passing through the textile material [5]. Fibers or fabrics containing PCM can be widely used in daily wear products such as coats, gloves, berets, underwear, and products with significant protective effects such as diving suits and ski suits [6]. Many factors must be considered when selecting a convenient PCM for protective clothing to achive ideal thermal insulation and regulation effects. Pause (1995) pointed out that the choice of PCM for a particular field of application depends on the phase transition temperature, which must be equal to the temperature range in which the heat flow through the material must be delayed [7]. The heat exchange that occurs during the phase change provides thermal protection by allowing users to store and dissipate heat to resist environmental thermal influences, thereby allowing users to interact with clothing [8,9]. Güler and Kut (2011) obtained microcapsules to provide temperature regulation in curtain fabrics and observed that the thermal comfort of the environment improved by 0.5-1.5 ºC [10].

The present study aimed to improve the thermal comfort of tight garments, which have a wide range of uses from sports to daily activities, in slightly cold to slightly warm ambient conditions. Five fabric structures suitable for the production of tights, which weight values are close to each other, were supplied by a manufacturer (Table 1). The wear trials of tight garments (with and without PCM) used in sports activities in outdoor conditions were conducted under three different ambient and activity conditions. A digital infrared camera was used and thermal images of the subjects were taken during three activity conditions (Testo 882, 320x 240 pixels, thermal sensitivity < 50 mK). In addition, the subjective comfort sensations of tight garments were measured depending on the temperature changes under ambient conditions by applying phase change materials to these fabric structures. The results showed that PCM-containing tights samples measured higher temperatures in the post-exercise period (except for slightly cold 16 C°). As the ambient temperature increased, the surface temperature of the tights garment increased and F5 coded tight with the highest thermal resistance value measured subjectively at the highest temperature, heaviest weight, lowest hand value, and hardest felt garment.

Table 1. Fabrics used in the experiments

Fabric Code	Knit	Yarn Composition	Pus/ Fayn	Weight (g/m^2)	Thermal Resistance ($K.m^2/W$)	Yarn Report
F1	S. Jersey	- Ne 28/1 Compact Combed Cotton, - 60 dtex Elastane % 90 Cotton - %10 Elastane	26"28	269.4	10. 66	Cotton+ Elastan
F2	Doube Face Jersey	- Ne 40/1 Compact Combed Cotton - 75/72 Denye Textured Punted PES -78 dtex Elastane %58 Cotton -%30 PES %12 Elastane	30"20	281.54	10.12	Front Face: Cotton Back Face: Cotton/ PES+Elastane
F3		-100/96 Denier Ecru Low Punted Textured PES - Ne 40/1 Compact Combed Cotton -78 dtex Elastane %48 PES- %41 Cotton- %11 Elastane	30"20	279.38	9.68	Front Face: PES Back Face: Cotton+ Elastane
F4		-100/96 Denier Ecru Textured Low Punted PES - Ne 38/1 % 88/12 Ring Polyester / Wool -78 dtex Elastane %49 PES -%40 PES+Wool- %11 Elastane	30"20	326.4	11.02	Front Face: PES Back Face: PES/Wool+ Elastane
F5	Gimped Punto Di Roma	-Ne 30/1, % 50/50 Combed Cotton/Polyester -75/36+40 Denye Ecru PES/Elastane % 70 Cotton/PES - %30 PES/ Elastane	34"20	253.72	14.74	1.Yarn: Cotton /PES 2.Yarn: PES/Elastane

Keywords: tight garment, thermal imaging, PCM, subjective comfort.

ACKNOWLEDGEMENT
This work was supported by Bursa Uludag University (project number: FGA-2021-632).

REFERENCES
[1] TÖZÜM, S., DEMIRBAĞ, S., AKSO, A.S. Investıgatıon of Thermoregulatıon Propertıes of the Heat Storıng Mıcrocapsule Applıed Fabrıcs. Textile and Engineer, 2011, Vol. 84, pp 8-14.
[2] CHAPMAN, R. Development in smart fabrics. United Kingdom: Pira International Ltd., 2006.
[3] KURU, A., ALAY AKSOY S. Phase Change Materials and Their Textile Applications. Textile and Engineer, 2012, Vol. 19, No.86, pp 41-48.
[4] ÇIMEN, E. Possibilities of bring in new properties to woven fabrics by microencapsulation method: Master Thesis, İstanbul Technical University, 2007, 73 pp.
[5] DEVECI, Ş., The use of microencapsulated phase change materials and special fibers to improve comfort characteristics of elastic bandages: Master Thesis, Ege University, 2009, 188 pp.
[6] NELSON, G. Application of Microencapsulation in Textiles. International Journal of Pharmaceutics, 2002, Vol. 242, pp 55–61.
[7] PAUSE, B. Development of Heat and Cold Insulating Membrane Structures with Phase Change Materials. Journal of Coated Fabrics, 1995, Vol. 25, No. 7, pp 59-64.
[8] BOAN, Y., Physical Mechanism and Charactarization of Smart Thermal Clothing: PhD Thesis, The Hong Kong Polytechnic University, 2005.
[9] MATTILA, H.R. Intelligent Textiles and Clothing. England: Woodhead Publishing Limited 2006.

[10] GÜLER, Z., KUT, D. Preparatıon and Application of Microcapsules For Thermal Regulating Polyester Curtain. Uludağ University Engineering- Architecture, 2011, Vol. 16, No. 1, pp 105-115.

A HYDROGEL/TEXTILE BASED ACTUATOR FOR SOFT ROBOTIC APPLICATIONS

Aylin Tokyürek[1], **Guldemet Basal**[2]
[1] *Ege University, Department of Textile Engineering, Bornova, İZMİR*
[2] *Ege University, Department of Textile Engineering, Bornova, İZMİR*
aylintokyurek@gmail.com

In recent years, there has been a growing trend toward developing intelligent textiles and utilizing them in soft robotics[1]. This is because textiles offer numerous advantages over the hard metals, composites, and plastics typically used in wearable robotic equipment [2,3]. However, in order to meet the growing demand for improved soft and wearable robotics, soft actuators must also be employed in addition to textiles. Soft actuators are deformable parts that can be energized by external inputs to produce desired motions and forces[4]. Currently, most soft actuators are made of smart hydrogels that have programmable shape deformations in response to external inputs[4,5]. However, these soft actuators often lack the necessary robustness, flexibility, and elasticity required for effective soft robotics applications. Therefore, there is a need for further development of soft actuators that can meet the rigorous demands of soft robotics.

In this study in order to overcome this problem we combined PEGDA hydrogel and silk fabric and created a humidity-responsive smart composite material for soft robotic applications. Poly(ethylene glycol) (PEG) is a well-known polymer used in many biomedical applications due to its hydrophilicity, water solubility, and high biocompatibility [6]. PEGDA is a derivative of PEG. It is produced by replacing two hydroxyl end groups around the PEG diol with acrylates. PEGDA is known as biologically inert and it is easily photo-polymerized[7].
Silk is a natural protein fiber derived from Bombyx mori larvae. Silk fibers have highly crystalline structure. They have moderately high tensile strength, good elasticity, and excellent toughness[8].

In the first part of the study PEGDA hydrogels were produced using photopolymerization process. Different PEGDA concentration rates and types of photoinitiators were used to obtain stable hydrogels. Among them 50 % PEGDA concentration and 2-hydroxy-2-methylpropiophenone (HOMPP) gave the best results. Following the hydrogel production hydrogel solutions were applied to the fabrics. A plain weave silk fabric (35g/m2) was used for the experiments. Hydrogel applied fabrics were washed and dried at 40^0C for 24 hours. As the hydrogel on the fabric dehydrated, it shrunk and pulled the fabric along its path of least resistance (Figure 1a). Rehydration of the fabric caused the swelling of hydrogel and fabric became almost flat again (Figure 1b). Presently, ongoing research is focused on examining the influence of hydrogel amount and application pattern on the shape change response of fabrics.

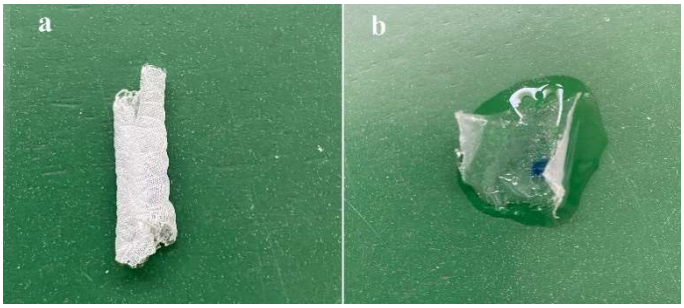


Figure 1. The humidity-responsive actuation of hydrogel applied fabric **a.** Dehydrated fabric; **b.**Rehydrated fabric

Keywords: Smart textiles, moisture responsive fabric, soft actuator, hydrogel, silk fabric

REFERENCES

[1] V. SANCHEZ, C.J. WALSH, R.J. WOOD, Textile Technology for Soft Robotic and Autonomous Garments, Adv. Funct. Mater. 31 (2021). https://doi.org/10.1002/adfm.202008278.

[2] C. FU, Z. XIA, C. HURREN, A. NILGHAZ, X. WANG, Textiles in soft robots: Current progress and future trends, Biosens. Bioelectron. 196 (2022). https://doi.org/10.1016/j.bios.2021.113690.

[3] A.F. YILMAZ, F. KHALILBAYLI, K. OZLEM, H.M. ELMOUGHNI, F. KALAOGLU, A.T. ATALAY, G. INCE, O. ATALAY, Effect of Segment Types on Characterization of Soft Sensing Textile Actuators for Soft Wearable Robots, Biomimetics. 7 (2022). https://doi.org/10.3390/biomimetics7040249.

[4] J. KIM, J.W. KIM, H.C. KIM, L. ZHAI, H.U. KO, R.M. MUTHOKA, Review of Soft Actuator Materials, Int. J. Precis. Eng. Manuf. 20 (2019). https://doi.org/10.1007/s12541-019-00255-1.

[5] M. DING, L. JING, H. YANG, C.E. MACHNICKI, X. FU, K. LI, I.Y. WONG, P.Y. CHEN, Multifunctional soft machines based on stimuli-responsive hydrogels: from freestanding hydrogels to smart integrated systems, Mater. Today Adv. 8 (2020). https://doi.org/10.1016/j.mtadv.2020.100088.

[6] C.C. LIN, K.S. ANSETH, PEG hydrogels for the controlled release of biomolecules in regenerative medicine, Pharm. Res. 26 (2009). https://doi.org/10.1007/s11095-008-9801-2.

[7] Y. WANG, B. ZHANG, M. MA, W. LU, J. WANG, Y. GUO, Synthesis of GelMA/PEGDA Hydrogel by UV Photopolymerization, Yingxiang Kexue Yu Guanghuaxue/Imaging Sci. Photochem. 35 (2017). https://doi.org/10.7517/j.issn.1674-0475.2017.04.019.

[8] S. CHEN, M. LIU, H. HUANG, L. CHENG, H.P. ZHAO, Mechanical properties of Bombyx mori silkworm silk fibre and its corresponding silk fibroin filament: A comparative study, Mater. Des. 181 (2019). https://doi.org/10.1016/j.matdes.2019.108077.

THE COATING OF POLIACRILONITRILE STRIP WITH NANOFIBERS PRODUCED BY ELECTROSPINNING

Mehmet Topalbekiroğlu[1], **M. İdris Aktaş**[2], **Behzat Yıldırım**[1]
[1]*Gaziantep University, Gaziantep/TÜRKİYE*
[2.]*Boyar Kimya San. ve Tic. A. Ş., Gaziantep/TÜRKİYE*
tbekir@gantep.edu.tr

In this study, it is aimed to coat polyacrylonitrile (PAN) stripswith nanofibers by electrospinning. Coating the PAN strip with nanofiber is the process of applying nanometer scale fibers to the surface of the strip. In the experimental study, the concentration of the polymer solution (PAN/DMF), voltage, flow rate, etc. parameters are optimized. Firstly, the nanofiber coating was studied depending on the time. Then, the PAN strip was twisted during coating. The properties of coated nanofiber strips such as distribution of nanofibers, bead formation, diameter of nanofibers, porosity and uniformity of nanofibers by scanning electron microscopy exanimated in this study.

Keywords: Polyacrylonitrile strip, nanofiber, electrospinning, coating, hybrid yarn

ACKNOWLEDGMENTS

This study was carried out by Boyar Kimya R&D Department (Project no:BS-001)

REFERENCES

[1] WANG, Y., WANG, Z., FU, H., LI, H., TAN, J. AND YANG, W. (2023), Chapter 5 - Preparation and functional applications of electrospun yarns, Functionalized Nanofibers, Synthesis and Industrial Applications, Pages 109-133.
[2] RAKHI, T., PRAGATI, M., PRERNA, B. AND JYOTI, S. (2023), Multifaceted approach for nanofiber fabrication, Fiber and Textile Engineering in Drug Delivery Systems, The Textile Institute Book Series, Chapter 8, Pages 253-283.
[3] LIU, Y. AND WU, F. (2023), Synthesis and application of polypyrrole nanofibers: a review, Nanoscale Adv., 5, 3606–3618.
[4] JIN, S., XIN, B. AND KAN, C. (2020), Electrospun Nanofibers and Applications: A Review. AATCC Journal of Research.
[5] NEMATI, S., KIM, SJ., SHIN, Y.M. ET AL (2019), Current progress in the application of polymeric nanofibers to tissue engineering. Nano Convergence 6, 36.
[6] QIAO, H. AND WEI, Q. (2012), Functional nanofibers in lithium-ion batteries. Functional Nanofibers and Their Applications, 197–208.
[7] TLILI, I. AND ALKANHAL, T. A. (2019), Nanotechnology for water purification: Electrospun nanofibrous membrane in water and wastewater treatment. Journal of Water Reuse and Desalination, 9(3), 232–248.
[8] PARK,J.H. AND RUTLEDGE,G.C.(2017),50th Anniversary perspective: advanced polymer fibers: high performance and ultrafine, Macromolecules 50 (15), 5627–5642.
[9] TEO, W. E. AND RAMAKRISHNA, S. (2006), A review on electrospinning design and nanofiber assemblies. Nanotechnology,17(14).
[10] KAJDIČ, S., PLANINŠEK, O., GAŠPERLIN, M. AND KOCBEK, P. (2019), Electrospun nanofibers for customized drug-delivery systems. Journal of Drug Delivery Science and Technology, 51, 672–681.

[11] WEI, L.AND QIN, X.H. (2016), Nanofiber bundles and nanofiber yarn device and their mechanical properties: a review, Text. Res. J. 86 (17), 1885–1898.
[12] ZHOU, F.L., GONG, R.H. AND PORAT, I. Nano-coated hybrid yarns using electrospinning, Surf. Coat. Technol. 204 (21–22) (2010) 3459–3463.
[13] BAZBOUZ, M.B. AND STYLIOS, G.K.(2012).A new mechanism for the electrospinning of nanoyarns, J. Appl. Polym. Sci. 124 (1) 195–201.
[14] KORKMAZ MEMIS, N., KAYABAŞI, G. AND YILMAZ, D. (2019), Development of a novel hybrid yarn production process for functional textile products, J. Ind. Text. 48 (9) (2018) 1462–1488.
[15] CHOI, S., MOON, S.H. AND KIM, T.K. Fabrication of capacitive yarn torsion sensors based on an electrospinning coating method, Polym. Int. 68 (11), 1921–1927.
[16] RAVANDI, S.A.H., SANATGAR, R.H. AND DABIRIAN, F.(2013), Wicking phenomenon in nanofiber-coated filament yarns, J. Eng. Fibers Fabr. 8 (3), 10–18.
[17] LIU, C.K., HE, H.J., SUN, R.J., FENG, Y. AND WANG, Q.S. (2016), Preparation of continuous nanofiber core-spun yarn by a novel covering method, Materials & Design, 112, 456–461.
[18] ZHOU, Y., WANG, H., HE, J., QI, K. AND DING, B. (2019), Highly stretchable nanofiber-coated hybrid yarn with wavy structure fabricated by novel airflow-electrospinning method. Materials Letters, 239, 1–4.
[19] HE, J.X., ZHOU, Y.M., WU, Y.C. AND LIU, R.T. (2014), Nanofiber coated hybrid yarn fabricated by novel electrospinning-airflow twisting method. Surface and Coatings Technology, 258, 398–404.
[20] ZHOU, F.L. AND GONG, R.H.(2009), Isaac Porat Nanocoating on filaments by electrospinning, Surface & Coatings Technology 204, 621–628.
[21] JIANG, G.J., ZHANG, J.R. AND JI,D.X.(2017), A novel approach for fabricating antibacterial nanofiber/cotton hybrid yarns, Fibers Polym. 18 (5), 987–992.
[22] YANG, Y.C. AND QUAN, Z.Z. AND ZHANG, H.N.(2022), Investigation on the processability, structure and properties of micro-/nano-fiber composite yarns produced by trans-scale spinning, J. Ind. Text. 51 (3_Suppl), 5409s–5426s.
[23] MAO, N., QIN, X.H. AND WANG, L.M. (2021), The migration behavior of electrospun nanofibers within cotton slivers in roller drafting and their effects on composite yarn quality, Text. Res. J. 91 (13–14), 1555–1564.
[24] YU, W., LI, X. AND HE, J. (2021), Graphene oxide-silver nanocomposites embedded nanofiber core-spun yarns for durable antibacterial textiles, J. Colloid Interface Sci. 584, 164–173.
[25] ZHOU, Y.M., HE, J.X. AND WANG, H.B.(2016), Carbon nanofiber yarns fabricated from co-electrospun nanofibers, Mater. Des. 95, 591–598.

DEEP LEARNING-BASED CONVOLUTIONAL NEURAL NETWORKS FOR ROTARY SCREEN PIGMENT PRINTING MACHINE PARAMETER ESTIMATION

Hüseyin Topçu[1], **Zahide Güleryüz**[1], **Mustafa Tuna**[1], **Güngör Durur**[2]
[1] *Dok-San Denizli Textile Industury and Trade Inc. R&D Center, Denizli, TURKEY*
[2] *Pamukkale University, Engineering Faculty, Textile Engineering Department, Denizli, TURKEY*
htopcu10@posta.pau.edu.tr

The textile manufacturing industry is based on human labor. Traditional rotary screen printing contains many processes requiring human labor, such as pattern design, printing paste preparation, screen preparation, and printing machine parameter determination. In rotating screen printing, the screen mesh number, bar size, press, and machine speed are all specified for each color in the pattern by a skilled worker. Before mass production, sample printing is done with an experience-based system a couple times. This requires time, consumes unnecessary resources, and increases the rate of faults and waste in production. In this project, the machine parameters of the ready-to-print pattern in rotation printing were estimated with a deep learning method based on convolutional neural network (CNN).

Machine learning attempts to solve problems by imitating people self-development through learning based on daily interactions. Deep learning is a sub-field of machine learning and is one of the most widely used artificial intelligence technologies today [1]. It is used in the textile industry to increase productivity, digitalization, recommendation systems, detect defects in fabric, reduce subjective analysis errors. The last 20 years of deep learning models for fabric defect detection and classification have been reviewed. The most commonly used deep learning models are CNN-based and generative models [2]. In [3], built an online CNN-based deep learning model for recommending customer preferences for patterns and colors in textile products. In [4], the subjective evaluation error in fabric wrinkle testing was eliminated using an RVFL algorithm optimized by the TSA method based on logistic maps and the usage of ResNet18 for crease imagine feature extraction. In order to classify and automatically recognize textile fabric patterns, transfer learning [5] and conventional neural network [6] deep learning models have been used.

In this study, multi-class classification deep learning conventional artificial neural network method was preferred to determine rotary screen printing machine parameters. Screen mesh number (holes/inch), bar size (mm), machine press, and speed (m/min) parameters were categorized using CNN based on color and figure images. The CNN model was applied to predict the machine parameters for the new pattern colors. The model was created using mass-produced printed pattern data. First, applying the K-means algorithm to images, the pattern figures are divided into clusters based on color. The number of pattern images was not sufficient to apply deep learning; therefore, images were rotated, mirrored, and noised to generate images. The color images of the pattern were then categorized in accordance with the printing parameters.

As a result of this study, owing to the model developed, it is possible to predict the printing machine parameters while the patterns are at the order step. Another purpose of this project is to eliminate the need for sample printing. By achieving this, manufacturing productivity is raised and laborer decision mistakes are reduced.

ACKNOWLEDGEMENTS
Thanks to Dok-San company for their contribution in this study. This work was supported under Grade No: 22-UPG-004 by Dok-San Textile R&D Center affiliates The Republic of Turkey Ministry of Science, Industry and Technology.

Keywords: Textile**,** rotary screen printing, conventional neural network, image classification

REFERENCES

[1] DOĞAN, F., TÜRKOĞLU, İ. Derin öğrenme modelleri ve uygulama alanlarına ilişkin bir derleme. Dicle Üniversitesi Mühendislik Fakültesi Mühendislik Dergisi, 2019, 10.2: 409-445.
[2] KAHRAMAN, Y., DURMUŞOĞLU, A. Deep learning-based fabric defect detection: A review. Textile Research Journal, 2023, 93.5-6: 1485-1503.
[3] TURKUT, Ü., et al. An Online Recommendation System Using Deep Learning for Textile Products. International congress on human-computer interaction, optimization and robotic applications (HORA), 2020, IEEE, 2020. p. 1-4.
[4] ZHOU Z., et al. Fabric wrinkle rating model based on ResNet18 and optimized random vector functional-link network. Textile Research Journal, 2023, 93.1-2: 172-193.
[5] MENG, S., et al. A multi-task and multi-scale convolutional neural network for automatic recognition of woven fabric pattern. Journal of Intelligent Manufacturing, 2021, 32: 1147-1161.
[6] NOPRISSON, H., et al. Fine-Tuning Transfer Learning Model in Woven Fabric Pattern Classification. Int. J. Innov. Comput. Inf. Control, 2022, 18.06: 1885.

WOOL BASED ACTIVATED CARBON FIBERS FOR CARBON DIOXIDE CAPTURE

Tugçe Töngüç Yalçınkaya[1], Sinem Koçak[2], Ahmet Çay[3], Jale Yanık[4], Çiğdem Akduman[5], E. Perrin Akçakoca Kumbasar[3]

[1]*Department of Textile Engineering, Graduate School of Natural and Applied Sciences, Ege University, Izmir, Türkiye*

[2]*Department of Chemistry, Graduate School of Natural and Applied Sciences, Ege University, Izmir, Türkiye*

[3]*Department of Textile Engineering, Faculty of Engineering, Ege University, Izmir, Türkiye*

[4]*Department of Chemistry, Faculty of Science, Ege University, Izmir, Türkiye*

[5]*Denizli Vocational School of Technical Sciences, Department of Textile Technology, Pamukkale University, Denizli, Türkiye*

ahmet.cay@ege.edu.tr

Global warming, which has become an alarming threat to the environment and human life, has emerged as a result of the increasing release of greenhouse gases into the atmosphere. Although many greenhouse gases such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), SOx are emitted into the atmosphere, carbon dioxide has the largest share among these gases. According to the IPCC report, in order to limit the increase in global warming to 1.5 °C compared to pre-industrial period, CO_2 emissions should be zeroed until the 2050s and other greenhouse gas emissions, especially methane, should be reduced simultaneously [1]. It was reported that it will not be possible to keep the world average temperature increase below 3 °C without the implementation of emission reduction practices as well as large-scale emission capture and storage [2]. Therefore, the development and use of CO_2 capture and storage (CCS) technologies is crucial to cope with the global demand for CO_2 emission reduction.

CO_2 capture by adsorption is of interest due to its low capital requirement, easy applicability and low energy consumption [3]. CO_2 adsorption is provided by the synergistic effect of physical adsorption within the micropores of the adsorbent material and chemical adsorption with nitrogenous functional groups on the surface. In this research, CO_2 adsorption by activated carbon fibers (ACFs) were investigated, where wool felts were used as the precursor material.

Wool felts were subjected to stabilization (300 °C, 2 h), carbonization (800-900 °C, 1 h) and activation processes for ACF production. Chemical activation method with potassium hydroxide (KOH) was used for activation process; KOH impregnated samples were activated at 700 °C for 1 h. Both carbonization and activation processes were carried out in a laboratory scale vertical fixed bed reactor. Mass yield calculation, elemental analysis, SEM analysis, BET analysis and CO_2 adsorption tests of the samples were carried out. The effects of carbonization temperature and KOH impregnation ratio on the characteristics and CO_2 adsorption performance of wool based ACFs were investigated.

It was observed that the mass yield after carbonization was similar for both carbonization temperatures; on the other hand, the mass yield of wool fibers after activation carbonized at higher temperature was found to be higher. Mass yield between 53-33% were obtained depending on the carbonization temperature and the KOH impregnation ratio. Increase in the KOH impregnation ratio led to a decrease in the mass yield. Similary carbon and nitrogen ratio decreased by the increase in the KOH impregnation ratio.

It was seen that the fibrous structure was preserved at all stages. As a result of the activation processes, tubular structures appeared at the fiber ends. It was observed that the surface area of the wool-based activated carbon fibers varied greatly according to the KOH impregnation ratio, and the surface area increased as the increase in the KOH impregnation ratio. Carbonization at 800 °C and activation at 1:3 KOH ratio led to a very high surface area of 1807 m^2/g. Although the surface area was very different for each processing parameter, the carbon dioxide adsorption performance of the samples carbonized at 800 and 900 °C and activated at 1:2 and 1:3 KOH impregnation ratios was found to be analogous and quite high (3.85-4.06 mmol/g). This was thought to be due to the synergistic effect of different microporosity and nitrogen content in each case.

In conclusion it was revealed that wool fibers are a very suitable natural alternative for the production of activated carbon fibers with very high surface area and considerable CO_2 adsorption capacity.

Keywords: Wool, activated carbon fiber, carbon dioxide adsorption,

The authors would like to gratefully acknowledge the financial support for this research received through the project (No:219M572) of The Scientific and Technical Research Council of Türkiye (TÜBİTAK).

[1] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press. [cited 05.06.2023]. Available on https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf
[2] HARVEY, C, GRONEWOLD, N, Greenhouse gas emissions to set new record this year, but rate of growth shrinks. [cited 05.06.2023]. Available on https://www.sciencemag.org
[3] BECHELANY, M, DROBEK, M, VALLICARI, C, ABOU CHAAYA, A., JULBE, A, MIELE, P. Highly crystalline MOF based materials grown on electrospun nanofibers. Nanoscale, 2015, 7, 5794-5802.

A NEW METHOD IN PRODUCTION OF MULTI-COMPONENT HYBRID YARN AND YARN PROPERTIES

Merve Turan[1], Osman Babaarslan[2] , Yağmur Olgun [2]
[1] *Calik Denim Tekstil/1.OSB 2. Cad.No:6 Yesilyurt/MALATYA*
[2] *Cukurova University / Balcalı,, 01330 Sarıçam/Adana*
merve.erkoc@calikdenim.com

With the rapid development of technology worldwide, the importance of yarn variety and fabric designs with new properties has increased as a result of the combination of textile products with different structures and properties using different production methods. Among these yarns, the most common are core yarns. In recent years, a new type of core yarn called Dual core spun yarn has been developed in order to improve the properties of core yarns such as recovery, stability, and dimensional change.
Core or hybrid yarn is a yarn structure consisting of core and sheath/coat fibers developed in order to benefit from the properties of two or more different components at the same time. The first of these fibers is the fibers in the form of filaments, which are used to add functional properties to the yarn and are expressed as "core" in the center of the yarn.
the other can be defined as the outer layer covering the core (wrap) with the fiber bundle, which is generally in the form of staples, which is mostly used due to its comfort feature.[1]

In this study, it is aimed to compare the performance of hybrid yarns in which core components (T400/Elastane, PBT/Elastane, PES/Elastane) are combined with hollow spindle technique with “s” and “z” twist direction and conventional ring double core yarns technique. The experimental set consisting of 3 groups (A, B, C) is shown in Table 1.

MATERIAL AND METHOD

In this study, T400, PBT and PES were used together with elastane as double core material. All yarns are produced in the same fineness. Groups A and B were obtained by twisting in different directions with the hollow spindle technique and group C is produced with conventional ring spinning system. The physical properties of all yarns were tested with the “Uster tensorapid” test device with 5 repetitions.
Test results were analysed comparatively. The results of the test are shown in Table 2.

Table 1. Set of Experiment

Sample	Description
A-1	18/1 (55T400+78 LYC S Twist)
A-2	18/1 (50 DEN PBT +78 LYC S Twist)
A-3	18/1 (50DEN PES + 78 LYC S Twist)
B-1	18/1 (55T400+78 LYC Z Twist)
B-2	18/1 (50 DEN PBT +78 LYC Z Twist)
B-3	18/1 (50DEN PES + 78 LYC Z Twist)
C-1	18/1 (55T400+78 LYC)
C-2	18/1 (50 DEN PBT +78 LYC)
C-3	18/1 (50DEN PES + 78 LYC)

RESULTS

Table 2. Test Results

Test	Group-1			Group-2			Group-3		
	PES	**PBT**	**T400**	**PES**	**PBT**	**T400**	**PES**	**PBT**	**T400**
Number (Ne)	18,00	18,00	18,00	18,00	18,00	18,00	18,00	18,00	18,00
Strength (cN/tex)	14,14	12,14	15,30	14,97	12,34	14,40	16,01	13,03	14,30
Elongation (%)	10,52	10,12	11,09	12,34	12,63	13,31	9,09	12,91	12,44
Unevenness (%CVm)	16,53	15,92	16,02	16,05	14,85	15,50	15,41	14,59	15,52
Hairness	5,99	5,92	6,02	6,23	6,11	6,27	6,00	6,84	6,84

Keywords: Core component, Hybrid Yarn, New method,Yarn Properties

[1] ALAŞEHIRLI, G. (2009). Ring İplik Eğirme Makinesinde İçi Boş İplik (Hollow Yarn) Eğirme Tekniklerinin Araştırılması ve İplik Özelliklerinin İncelenmesi, Süleyman Demirel Üniversitesi Fen Bilimleri Enstitüsü, Tekstil Mühendisliği Anabilim Dalı, Yüksek Lisans Tezi, Isparta.

PRODUCTION AND CHARACTERIZATION OF MICROCRYSTALLINE CELLULOSE PARTICLES FROM CELLULOSIC FIBER WASTES

Gizem Ceylan Türkoğlu[1], Ümit Halis Erdoğan[1], Aylin Ziylan Albayrak[2], Ayşe Merih Sariişik[1]

[1] Department of Textile Engineering, Dokuz Eylul University, İzmir, Türkiye
[2] Department of Metallurgical and Materials Engineering, Dokuz Eylul University, İzmir, Türkiye
umit.erdogan@deu.edu.tr

Cellulose is a natural polymer that is recognized as the most widespread macromolecule on Earth, with an estimated annual production rate of more than 10^{11} tons [1, 2]. The textile industry is estimated to be the second largest contributor to water and carbon footprint, accounting for 10% of global carbon emissions [3]. Tens millions of tons of textile waste is estimated to be produced every year [4]. Using cellulosic fiber wastes can support economic and environmental recycling. One of the usage areas of these wastes is the production of nano and micro-sized fibers, which has as attractive properties like high strength, good stiffness, and a large surface area. Composites incorporating nano/micro cellulose can be beneficial in a variety of industries, including biomedical, automotive, and construction applications regarding improved mechanical and fluid handling properties.

In this work, we synthesized and analyzed micro-scale cellulose particles from textile waste in order to use them as reinforcing components in composites. For this, waste jute yarns and waste regenerated cellulose fibers were provided. The microfibers were produced via a two-stage chemical-mechanical acid hydrolysis technique involving a nitric acid (HNO_3)-acetic acid (HAc) solution and mechanical grinding. Optical microscopy, scanning electron microscopy (SEM), atomic force microscopy (AFM), and particle size distribution analysis were used to study morphological features. X-Ray Diffraction Analysis (XRD), Thermogravimetric Analysis (TGA), and Fourier Transform Infrared Spectroscopy (FT-IR) were carried out to investigate the crystallography, thermal stability, and chemical structure of the cellulose particles, respectively. The degree of polymerization and moisture content were also determined.

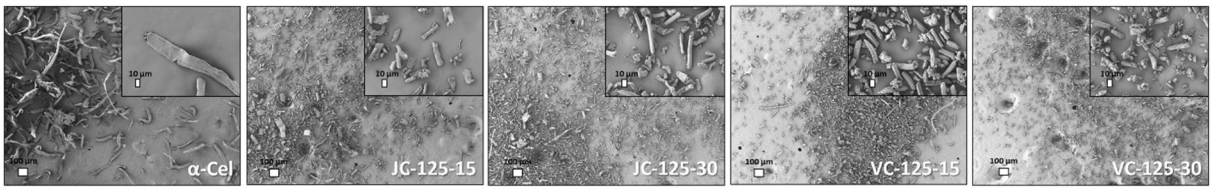


Figure 1. SEM images of micro-crystalline cellulose particles

SEM micrographs of cellulose particles at different magnification displayed in Figure 1. Cellulose particles obtained from regenerated cellulose fibers (VC-125-15 and VC-125-30) and jute fibers (JC-125-15 and JC-125-30) are significantly smaller than those obtained from commercial products (α-Cel). The particle sizes of the samples range between 10-15 µm, and the lengths range between 10-100 µm. It was found that when the processing temperature increased, the particle distribution became more homogeneous. Although there are smaller particles in the sample, the cross-section of the α-Cel sample is flattened, its width is in the range of 30-40 µm, and the fiber length is in the range of 300 - 500 µm.

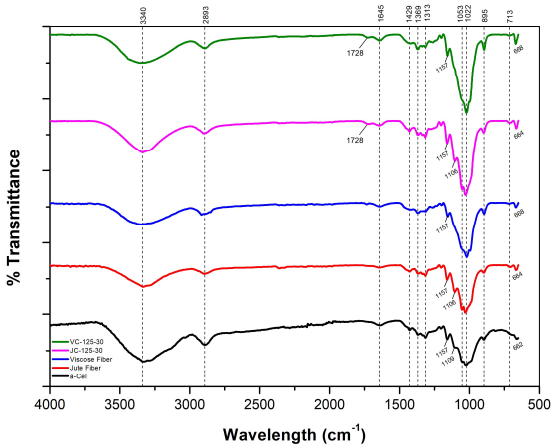


Figure 2. FT-IR spectra of micro-crystalline cellulose particles

FT-IR analysis was used to analyze and compare the chemical structures of micro-crystalline cellulose particles to commercial α-Cel (Figure 2). The FT-IR spectra of the samples made from viscose and jute wastes matched the most prominent bands determined in α-Cel; however, the intensities of the transmission bands differed. The band at 1430 cm^{-1} is related to the crystalline structure of cellulose, whereas the band at 896 cm^{-1} is related to the quantity of amorphous area. The empirical crystallinity index is defined as the ratio of these two bands. The ratio of these peaks was found higher for jute samples than regenerated cellulose samples. Considering the effect of process parameters on cellulose particles, the average particle size and distribution of the samples obtained from jute and regenerated cellulose wastes under optimum conditions (125 °C and 30 minutes) were similar. But the regenerated cellulose samples (28.41 µm) had a relatively smaller average particle size than the jute samples (28.91 µm) and the particle distribution was more homogeneous. Cellulose, a very inexpensive and abundant natural material, offers good mechanical qualities and structural stability. It is feasible to use the products created as part of the study as additives in composites and as green adsorbents.

Keywords: Jute, regerenated cellulose, cellulosic waste, microcrystalline cellulose

Acknowledgements: This study was supported by Dokuz Eylul University under the project number 2019.KB.MLT.002.

[1] KIM, J.H., SHIM, B.S., KIM, H.S., LEE, Y.J., MIN, S.K., JANG, D., ABAS, Z. & KIM, J. Review of nanocellulose for sustainable future materials. International Journal of Precision Engineering and Manufacturing-Green Technology, 2015, 2, pp 197-213.
[2] BROWN JR, R. M. Cellulose structure and biosynthesis: what is in store for the 21st century?. Journal of Polymer Science Part A: Polymer Chemistry, 2004, 42(3), pp 487-495.
[3] CONCA J (2015) Making climate change fashionable - the garment industry takes on global warming. Forbes https://www.forbes.com/sites/jamesconca/2015/12/03/making-climate-change-fashionable-the-garment-industry-takes-on-global-warming/?sh=2d7b6d6179e4. Accessed 3 April 2023
[4] NIINIMÄKI, K., PETERS, G., DAHLBO, H., PERRY, P., RISSANEN, T., GWILT, A. The environmental price of fast fashion. Nature Reviews Earth & Environment, 2020, 1(4) pp 189-200.

INVESTIGATION OF THE PVA SOLUTIONS PROPERTIES ON THE ELECTROSPINNING MAT

Gizem Ceylan Türkoğlu[1,2], **Dilyana Nikolaeva Gospodinova**[3], **Fabien Salaün**[2]
[1] *Dokuz Eylul University, Department of Textile Engineering, İzmir, Türkiye*
[2] *Univ. Lille, ENSAIT, ULR 2461 - GEMTEX - Génie et Matériaux Textiles, F-59000 Lille, France*
[3] *Technical University of Sofia, Faculty of Electrical Engineering, Department of Electrical Apparatus, Sofia, Bulgaria*
gizem.turkoglu@deu.edu.tr

The electrospinning offers a process for fibrous surfaces with exceptional mechanical properties, large surface areas, and diameters on the order of several nanometres. Poly(vinyl alcohol) (PVA) has low cytotoxicity, good biocompatibility, and favourable electro-spinnability without needing hazardous solvents that makes it a great candidate for electrospinning in medical textile applications [1]. Electrospinning significantly impacted by the type of PVA with different molecular weights (Mw) and degrees of hydrolysis (DH) which is directly affects physical and chemical properties, working concentration, fibre morphology and cross-section and, bead formation [2]. The study aims to determine the influence of the physicochemical properties of PVA on the ability to obtain an electrospun nonwoven mat before their functionalization with essential oils for the application of wound dressings. Thus, the relationship between viscosity, concentration, and morphology of electrospun fibres were examined based not only on literature data but also on our experimental results.

PVA in a range of 9,000-130,000 g/mol Mw was purchased. PVA aqueous solutions were prepared 24 hours prior performing electrospinning by a vertical set-up. A single stainless-steel nozzle with a 22-gauge was used and samples were collected with a static collector. Taylor cone formation was monitored simultaneously by a digital camera by different working parameters. The kinematic viscosity (mm^2/s) was determined using an Ubbelohde viscometer the flow time in seconds (t). α is the constant for the Ubbelohde glass (α=0.02937 for 0.47 mm capillary Ubbelohde, type 53213). Intrinsic viscosity which is a measure of the hydrodynamic volume of a polymer in solution, was calculated regarding Huggins-Kramer extrapolation of the viscosity data to infinite dilution from the zero-shear viscosities of the various concentration series [3]. A rotational viscosimeter, was used to measure the viscosity of the solutions between 1.9-1000 s^{-1} shear rates at room temperature. Scanning electron microscopy (SEM) was used to observe the surface morphology of electrosprayed and electrospun PVA and the image analysis was used to evaluate the size distribution.

The viscosity of the polymer solution has an influence on the forming and stability of the polymer jet and resultant mat. Morphologies of PVA mats obtained by the electrospinning in the study was given in Figure 1 considering molecular weight, Berry number (Be=[η]C), and concentration and compared with literature. The SEM images of PVA mats are presented in Figure 2. When the concentration of the solution reached to specific rate called the critical concentration (C*), polymer chains shifts to a semi-dilute unentangled regime at where beaded fibres occur ($4<C^*=B_e<9$). The entanglement concentration (C_e) is the concentration at which considerable viscosity increases between the semi-dilute unentangled and semi-dilute entangled regimes and stable fibres are formed (B_e~9)[4].

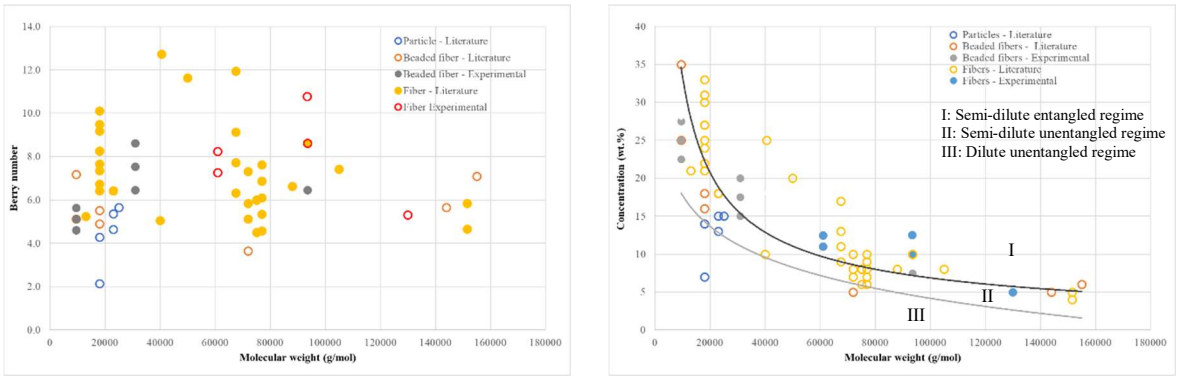


Figure 1. Morphologies obtained by different concentrations of PVA on different molecular weight

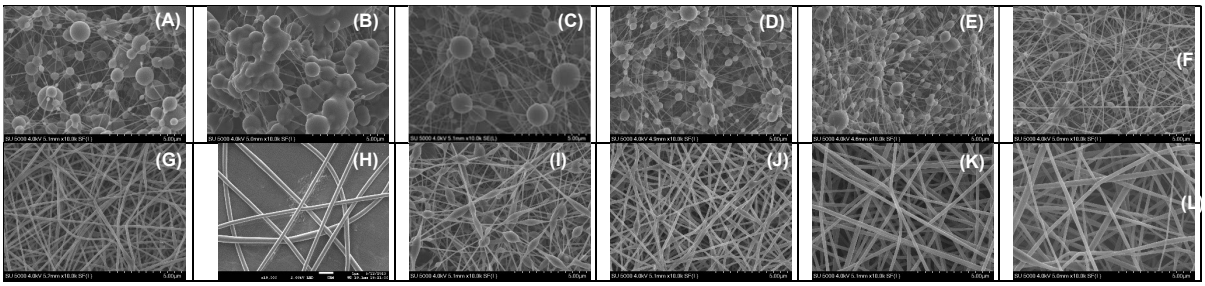


Figure 2. SEM Images of PVA electrospun mats with different wt% and M_W; M_W:9,000-10,000: (A) 22.5 wt% (B) 25 wt% (C) 27.5 wt%; M_W:31,000: (D) 15 wt% (E) 17.5 wt% (F) 20 wt%; M_W:61,000: (G) 11 wt% (H) 12.5 wt% M_W:89,000-98,000: (I) 7.5 wt% (J) 10 wt% (K) 12.5 wt%; M_W:130,000: (L) 5 wt%

In our study the beaded fibres were formed where B_e was between 4.6-8.6. The beadless nanofiber formation was observed for the samples having M_w 31,000 and 61,000 (B_e=7.2 to 10.8) (Figure 2.G, J, K and H). The high molecular weight mat with fibrous structure (Figure 2.L) had a lower B_e=5.3. The relationship between B_e and fibre diameter was also examined. The main discrepancies with the literature are related to the definition of each regime, the morphologies studied, and the degree of hydrolysis of the PVA used. Accordingly, the PVA mats from MW:61,000 11 wt% and 12.5 wt%, MW: 89,000-98,000 10 wt% and 12.5 wt%, MW:130,000 5 wt% samples presented desired properties due to their relatively uniform diameter distribution in nanoscale and circular cross-sections without beads (Figure 2.G, H, J, K and L). These samples were selected as optimum formulations for the inclusion of essential oil for medical purposes in further studies.

Keywords: Electrospinning, Electrospraying, Poly(vinyl alcohol), viscosity, molecular weight

ACKNOWLEDEGMENT

This research is funded by Turkish Scientific and Technological Research Council (TÜBİTAK) under 2219 Post-Doctorate Research Program(1059B192201394), and PHC RILA 48072X.

REFERENCES

[1] CANO, A.I., CHAFER, M., CHIRALT, A., GONZALEZ-MARTINEZ, C. Physical and microstructural properties of biodegradable films based on pea starch and PVA. Journal of Food Engineering, 2015, 167, pp 59–64.
[2] KOSKI, A., YIM, K., SHIVKUMAR, S. Effect of molecular weight on fibrous PVA produced by electrospinning. Materials Letters, 2004, 58, pp 493–497.

[3] BERCEA, M., MORARIU, S., RUSU, D. In situ gelation of aqueous solutions of entangled poly(vinyl alcohol). Soft Matter, 2013, 9, pp 1244–1253.
[4] TAO, J, SHIVKUMAR, S. Molecular weight dependent structural regimes during the electrospinning of PVA. Materials Letters, 2007, 61, pp 2325–2328.

EXPANDING OPPORTUNITIES WITHIN THE UV PROTECTION OF ARAMID FIBERS: MATERIAL INDEPENDENT LBL TECHNOLOGY

Yeşim Ünvar[1], Ayşe Merih Sarışık[2], Şule Sultan Uğur[3], Aylin Ziylan Albayrak[4]
[1] *Dokuz Eylül University, Graduate School of Natural and Applied Sciences, İzmir, Turkey*
[2] *Dokuz Eylül University, Textile Engineering Department, İzmir, Turkey*
[3] *Süleyman Demirel University, Textile Engineering Department, Isparta, Turkey*
[4] *Dokuz Eylül University, Metallurgical and Materials Engineering Department, İzmir, Turkey*
yesimunvar@gmail.com

Aramid fiber is one of the key materials in numerous cutting-edge fields owing to its outstanding integrated performances, especially high strength. However, aramid fiber suffers from poor UV resistance which deteriorates its superior mechanical properties [1, 2]. From a strategic standpoint, severe UV-induced strength losses are unacceptable due to the special requirements in application fields like space, aviation, defense. Therefore, minimizing these damages with UV protective coatings is of great interest both in academia and industry. However, the inert nature of aramid fibers makes coating a very challenging task. Hence, prior to any surface treatment, aramid fiber is mostly pretreated with acid or alkali, which results in fiber damage [1,2]. Likewise, semiconductors with strong UV absorption pose the risk of damaging the aramid fibers themselves since they are also photocatalysts [3]. Thus, the main challenge is not only developing a robust UV protective coating but also readily integrating it without compromising the mechanical properties of aramid fibers. Currently, most methods promising effective results are unfortunately complicated, difficult or require special machinery [4, 5]. In contrast, the Layer by Layer (LbL) self-assembly approach, has been demonstrated to be a simple yet highly versatile and powerful strategy to exceed limitations in the existing UV protective modifications of aramid-based materials [6, 7]. Furthermore, utilization of the mussel-inspired surface chemistry, synthetic polymers with catechol-polyamine (CPA) functionalities, has proven to be an efficient and practical approach for material-independent LbL deposition into inert surfaces such as aramid fibers [8].

This study puts particular emphasis on expanding opportunities of LbL technology with the goal of enhancing the UV resistance of aramid materials while minimizing fiber damage. Instead of using abrasive pretreatments, we propose a mussel-inspired coating approach for the LbL self-assembly of UV-protective nanoparticles onto aramid fibers. A CPA aqueous solution consisting of catechol (30 mM) and tetraethylenepentamine (10 mM) was prepared by ultrasonication. Aramid yarns were immersed in the CPA solution for 24 hours and then dried for 10 minutes at 100 °C. Aqueous anionic and cationic dispersions of CeO_2 nanoparticles (1 g/L) were prepared by ultrasonication adjusting pH with NaOH and HCl, respectively. CPA coated aramid yarns were dipped into these anionic and cationic CeO_2 dispersions, respectively and washed in each sequential step. Ten layers of CeO_2 nano coatings were obtained on aramid yarns by repeating this cycle at room temperature and dried for 10 minutes at 100 °C.

The UV-Vis spectrum of the CPA solution confirmed polymerization and indicates the presence of favorable conditions for implementing a material-independent LbL coating. The findings demonstrated that the use of mussel-inspired surface chemistry provides a strongly adhesive sublayer, effectively overcoming the inert nature of aramid fibers without the need for abrasive pretreatments. This opportunity was effectively utilized in the self-assembly of CeO_2 nanoparticles on CPA-coated aramid yarns, and the effectiveness of the LbL process was confirmed through FTIR-ATR, XPS, and SEM findings. Tensile tests confirm the feasibility of

creating nanocoatings via the LbL technique, ensuring high UV protection without compromising aramid fiber tensile properties. In conclusion, LbL nano-coating holds promise in improving both the UV resistance and tensile properties of the aramid yarns offering a relatively easy, gentle, and eco-friendly UV protection alternative.

Keywords: aramid fiber, UV protection, catechol-polyamine coating, Layer by Layer, tensile strength

ACKNOWLEDGMENT

This study is submitted as a part of TÜBİTAK project number 122M578, and the Turkish Council of Higher Education 100/2000 doctoral scholarship of Yeşim Ünvar.

REFERENCES

[1] ZHU, J., YUAN, L., GUAN, Q., LIANG, G., GU, A. A novel strategy of fabricating high performance UV-resistant aramid fibers with simultaneously improved surface activity, thermal and mechanical properties through building polydopamine and graphene oxide bi-layer coatings. Chemical Engineering Journal, 2017, 310, 134-147.

[2] ZHANG, H., LIANG, G., GU, A., YUAN, L. Facile preparation of hyperbranched polysiloxane-grafted aramid fibers with simultaneously improved UV resistance, surface activity, and thermal and mechanical properties. Industrial & Engineering Chemistry Research, 2014, 53 (7), 2684-2696.

[3] YASUKAWA, A., TAMURA, J. Preparation and structure of titanium-cerium-calcium hydroxyapatite particles and their ultraviolet protecting ability. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 2021, 609, 125705.

[4] CHEN, F., ZHAI, L., YANG, H., ZHAO, S., WANG, Z., GAO, C., ZHOU, J., LIU, X., YU, Z., QİN, Y., XU, W. Unparalleled armour for aramid fiber with excellent UV resistance in extreme environment. Advanced Science, 2021, 8 (12), 2004171.

[5] CAI, H., SHEN, D., YUAN, L., GUAN, Q., GU, A., LIANG, G. Developing thermally resistant polydopamine@ nano turbostratic BN@ CeO2 double core-shell ultraviolet absorber with low light-catalysis activity and its grafted high performance aramid fibers. Applied Surface Science, 2018, 452, 389-399.

[6] ÜNVAR, Y., SARIIŞIK, A.M. and UĞUR, Ş.S. Layer by layer self-assembly approach in the UV protective modification of aramid-based materials. In 8th International Technical Textiles Congress: Proceedings Book, Edited By ALPYILDIZ, T. Online: Dokuz Eylül University, Faculty of Engineering, Department of Textile Engineering, October, 2022, 48-53.

[7] ZHOU, L., YUAN, L., GUAN, Q., GU, A., LIANG, G. Building unique surface structure on aramid fibers through a green layer-by-layer self-assembly technique to develop new high performance fibers with greatly improved surface activity, thermal resistance, mechanical properties and UV resistance. Applied Surface Science, 2017, 411, 34-45.

[8] WANG, L., SHI, Y., CHEN, S., WANG, W., TIAN, M., NING, N., ZHANG, L. Highly efficient mussel-like inspired modification of aramid fibers by UV-accelerated catechol/polyamine deposition followed chemical grafting for high-performance polymer composites. Chemical Engineering Journal, 2017, 314, 583-593.

ENVIRONMENTALLY-FRIENDLY AND SUSTAINABLE 100% COTTON FABRIC PRODUCTION FROM FIBERS OBTAINED FROM FINAL CONSUMER TEXTILE WASTES

Merve Yarali[1], Serdar Kaymakçi[1], Serkan Alsan[2], Senem Pak[3], Ayşegül Koyuncu Okca[4]
[1]*Menderes Textile Industry and Trade Inc. R&D Center, Denizli / Turkey*
[2]*Menderes Textile Industry and Trade Inc. R&D Center, Denizli / Turkey*
[3]*Pamukkale University, Denizli Vocational School of Technical Sciences, Textile, Clothing, Shoes and Leather Department Textile Technology Program, Denizli / Turkey*
[4]*Pamukkale Üniversitesi, Denizli Teknik Bilimler Meslek Yüksekokulu, El Sanatları Bölümü Denizli / Turkey*
merveyarali@arge.menderes.com

Today, the production of textile products is increasing rapidly due to the developing fashion speed and rapid population growth. As a result of this developing change, natural resources are consumed rapidly and nature is polluted more and more every day [1]. In order to benefit from natural resources effectively and for a longer time, certain methods should be applied for the recycling of materials with economic value instead of waste wastage [2]. Recycling can be defined as the inclusion of recyclable waste materials, which have been used or out of use in any way, into the re-production process as raw materials with different methods. After the metal sector, the textile industry is one of the industries that consume raw materials, water, chemicals and energy and also pollute the environment the most [3]. Textile, which is one of the leading industrial sectors, has a very important place as more than 95% of it can be recycled and used. With recycling, significant contributions can be made to the world in terms of social, economic and environmental aspects. Many countries have taken measures in this regard and accelerated their work on an industrial basis [4]. This increased sensitivity towards environmental problems has encouraged the consumer to increase the recycling of post-consumer product waste. The use of recycled fibers has gained great importance in the textile industry due to increasing environmental awareness, legal requirements for greater sustainability and raw material costs [5]. The decomposition of degradable textiles produces methane, while organic textiles such as wool produce ammonia upon decomposition. Synthetic textiles do not degrade and therefore accumulate in landfills, creating both environmental and social problems. In terms of resource, post-industrial textile waste are completely new materials, but they are discarded without any use. Therefore, the development of recycling solutions for post-industrial textile waste is important to recover their true value and to minimize environmental pollution when they are disposed of or incinerated [6]. In this project work, as Menderes Tekstil, it is planned to obtain fibers from post-consumer textile wastes in order to obtain more environmentally friendly and sustainable products, taking into account the wishes of the customers and also considering the future generations, and in this context, fabric constructions have been developed and new products have been designed. In our study, firstly, the quality of post-consumer waste was determined. Later development of various constructions. Making yarn and weaving production depending on the developed construction. Performing unit operations by applying the process steps to be processed in finishing according to the type and quality of the fabric produced. The fabric obtained is transformed into the product requested by the customer with the garment process. As a result of our project work, we aim to be one of the leading companies in home textile products by using post-consumer wastes by adopting eco-system sensitive, more environmentally friendly and zero waste method. To contribute to our company and our country's economy by producing such sustainable products in addition to our standard production.

Keywords: Textile, Post-consumer textile waste, Recycling, Sustainability

[1] Alpat, FE. What is slow fashion? Mediterranean Art, 2011, 4(8), 44-47.
[2] Hanay, Ö. Koçer, N. Determination of the Recovery Potential of Solid Wastes in the City of Elazig. Fırat University Journal of Science and Engineering Sciences, 2006, 18(4), 507-511.
[3] Bayraktar, T. Chapter 1: Ecology in Textile and Apparel Industry. Ecology and Ecological Labels in the Textile and Apparel Sector, Organized by Istanbul Textile and Apparel Exporters' Association. Istanbul: Itkib R&D and Legislation Branch, 2005.
[4] Türemene, M. Demir, A. Özdoğan, E. Recycling and Its Importance for the Textile Industry. Pamukkale University Journal of Engineering Sciences, 2019, 25(7),805-809.
[5] Domina, T. Koch, K. Consumer Reuse and Recycling of Post-Consumer Textile Waste, Journal of Fashion Marketing and Management, 1999, 3(4), 346-359.
[6] Dissanayake, DGK. Weerasinghe, DU. Thebuwanage, LM. Bandara, UAAN.
It is an Environmentally Friendly Sound Insulation Material from Post-Industrial Textile Wastes and Natural Rubber. Journal of Structural Engineering, 2021, 33.

EFFECT OF THERMAL TREATMENTS ON HYGROSCOPIC PROPERTIES OF BIOLOGICALLY DEGUMMED OKRA BAST FIBERS

Nazire YILMAZ
Uşak University, Facultyt of Engineering, Department of Textile Engineering, Türkiye

In this study, bast fibers that have been extracted from okra (Abelmoschus esculentus) plant via biological degumming (water retting) were thermally treated under different temperatures for varying durations. Effects of thermal treatments on hygroscopic properties of fibers have been investigated.

Throughout the last several decades, environmental sustainability has become a major issue in production industries. Within this concept, agro-residual materials stand out promising as they exhibit renewability and biodegradability. They do not lead to depletion of biocarbon resources and exhaustion of dump areas. Additionally, they do not necessitate allocation of arable land solely for raw material production. Furthermore, they provide quality addition to the farmers and boost economic growth for rural areas [1], [2].

The response of plant fibers against high temperatures is important in predicting their performance during production, processing and use under high-temperature conditions. On the other hand, hydrophilicity of plant fibers is another important factor in evaluating their usefulness in different utilization areas. Hydrophilicity is a wanted phenomenon in textiles use for comfort purposes, whereas it is not welcome in technical applications such as use in polymeric composites as it ruins dimensional stability, structure integrity and maintaining mechanical strength in environments exposed to humidity [3], [4].

Okra plant stems were obtained from farms following completion of okra fruit. The collected okra stems were water-retted for 60 days in winter season. Then, fibers were separated manually and scoured using soda and soap. The scoured fibers were heat-treated at 100 °C - 160 °C for 2.5 h to 10 h in a dry oven.

Fibers were characterized in terms of their linear density (ASTM D 1577-07), moisture content (ASTM D2495–07), water absorptive capacity (EDANA 10.3-99, ISO 9073-6.2000), and time-dependent hygroscopic behavior (modified RILEM method).

Linear density, moisture content, water absorption capacity and time-dependent hygroscopicity of untreated and heat-treated fibers are shown in Fig 1 (a), (b), (c) and (d), respectively.

As a fiber of natural origin, okra fibers show great variability in results in contrast to synthetic fibers. Linear density of okra bast fibers range between 6.70-12.3 tex. The highest linear density belongs to untreated okra bast fibers. Being exposed to high temperature, constituents in the fiber structure may have disintegrated. For 100°C and 160°C treatment the linear density shows a decreasing trend with increment in duration.

As a lignocellulosic fiber, okra bast fibers show highly hydrophilic structure. Moisture content of okra bast fibers range between 6.4%-8.6%. This finding is in agreement with former literature on okra bast fibers 6.74% reported by Khan et al. [4].

Okra fibers can absorb 5 to 9 times of their initial weight. Water holding capacity of okra fibers increases with increment in immersion duration. Nouri et al. [3] reported a similar trend. On the other hand, heat-treated fibers show greater results. This may be linked with decreased linear density leading to greater specific surface area and capillary effect.

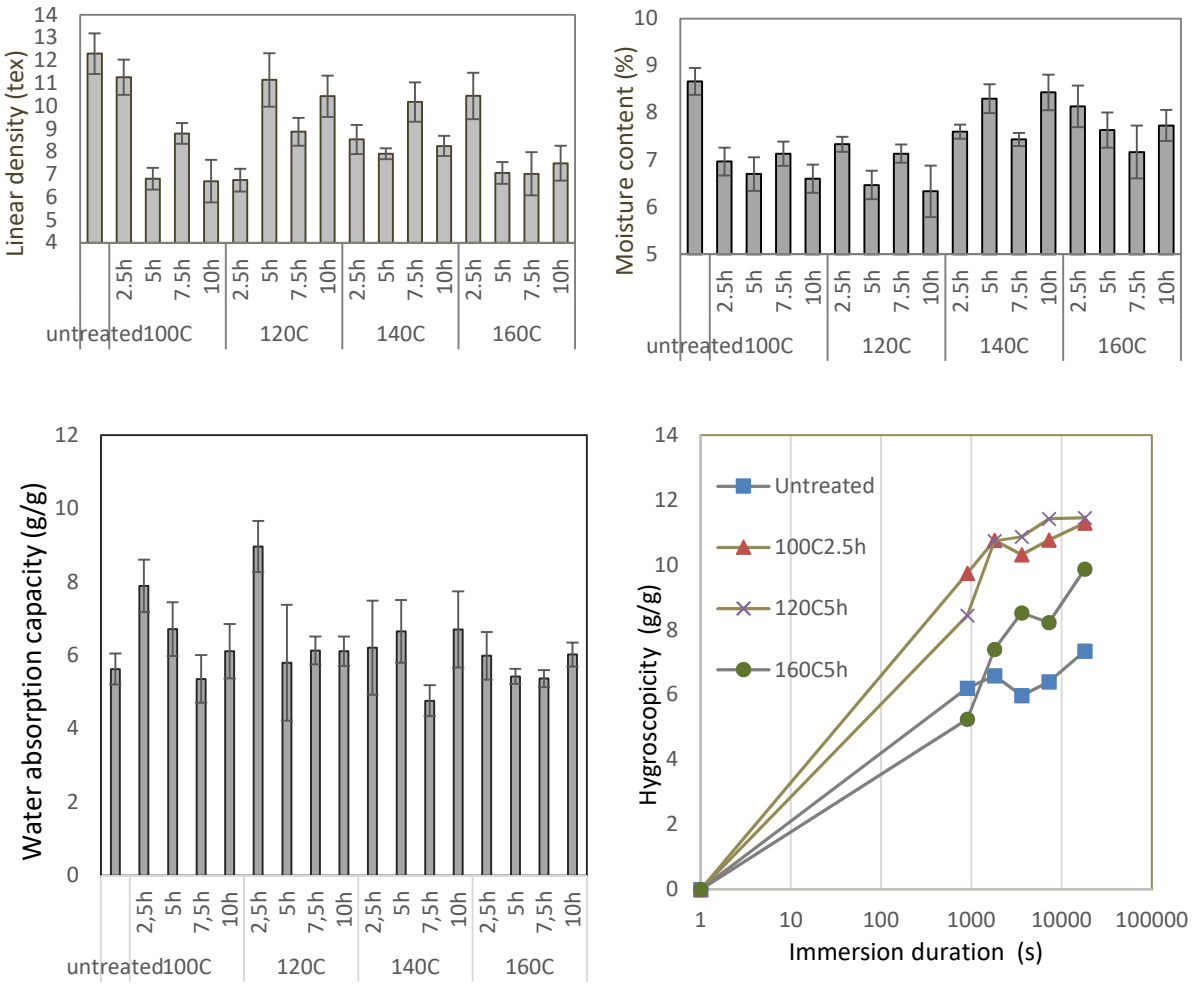


Figure 1. Effect of thermal treatment on a) linear density (tex), b) moisture content (%), c) water absorption (g/g), and d) time dependent hygroscopic behavior (g/g) of okra bast fibers. Error bars represent standard errors. Figure 1 (d) is shown in logarithmic scale.

Keywords: agro-residual fibers, characterization, hygroscopicity, thermal treatment

[1] S. OCHI, H. TAKAGI, AND R. NIKI, "Mechanical properties of heat-treated natural fibers," Zair. Soc. Mater. Sci. Japan, 2002, vol. 51, no. 10, pp. 1164–1168, doi: 10.2472/jsms.51.1164.
[2] E. D. KOCAK, N. MERDAN, I. MISTIK, AND B. Y. SAHİNBASKAN, "Fiber Extraction from Okra Plant Agricultural Wastes, Their Characterizations and Surface Modifications by Environmental Methods," Sustainable Innovations in Textile Fibers, Springer, pp. 53–80, 2018, doi: 10.1007/978-981-10-8578-9_3.
[3] M. NOURI, M. TAHLAITI, F. GRONDIN, AND R. BELARBI, "The Influence of Chemical and Thermal Treatments on the Diss Fiber Hygroscopic Behaviors," J. Nat. Fibers, 2020, pp. 0–14, 2020, doi: 10.1080/15440478.2020.1848733.
[4] G. M. A. KHAN, N. D. YILMAZ, AND K. YILMAZ, "Effects of alkalization on physical and mechanical properties of biologically degummed okra bast and corn husk fibers," J. Nat. Fibers, 2022, vol. 19, no. 3, pp. 1126–1136.

THE APPLICATION OF ARTIFICIAL INTELLIGENCE FOR ASSEMBLY LINE BALANCING IN THE CLOTHING INDUSTRY

Chaimae Zouhri[1,2,3], Faouzi Khedher[3], Amel Babay[3] , Mustapha Hlyal[1,2], Jamila El Alami[1]

1 LASTIMI Laboratory, University Med V in Rabat
2 Center of Excellence in Logistics (CELOG), ESITH, Casablanca, Morocco.
3 Textile Engineering Laboratory, University of Monastir, Monastir, Tunisia
zouhrishaimaa@gmail.com

ABSTRACT
This review explores AI's role in clothing industry assembly line balancing, focusing on labor-intensive settings. Algorithms like neural networks, branch-and-bound, and meta-heuristics are evaluated through experiments, showing potential for cost reduction and efficient labor allocation. While AI holds promise for optimizing assembly lines, further research is needed for clothing-specific challenges. This study underscores the need for increased automation in clothing manufacturing processes and emphasizes AI's potential in enhancing production efficiency.

INTRODUCTION
The application of artificial intelligence (AI) techniques in manufacturing, specifically assembly line balancing, has received significant attention from researchers to remain competitive in the global market. However, the clothing industry lags behind other industries in the level of automation in the assembly phase of the manufacturing process. This review aims to investigate the implementation of AI in the clothing industry with an emphasis on balancing assembly lines that involve a significant amount of labor.

LITERATURE REVIEW
Line balance is very important in the apparel and textile sectors. Scientists discuss this at conferences and exchange knowledge. A chronological overview of articles from 2010 to 2022, focusing on the application of AI in textile assembly line accounting [1]. In clothing manufacturing, AI-based methods have become mainstream. A genetic algorithm balances fashion lines by assigning different skills to operators [2][3]. A swarm of particles with local search achieves equilibrium on the multitasking line [4].
The role of AI in textiles is being explored. A hybrid approach combines tradition and sales forecasting to increase production and reduce costs [5]. Like neural networks, machine learning optimizes task flows, reduces cycle times, and increases efficiency [6] [7].
Examine the impact of AI on textile supply chain management. Intelligent systems improve planning, quality, forecasting, sales [8] and efficiently address industry complexity. In summary, AI will enhance the apparel and textile industry by improving efficiency, cost effectiveness and supply chain management. As research progresses, advances in AI will determine the future of this dynamic industry [9][10].

RESULTS AND DISCUSSION
The literature review shows that AI techniques can be applied to various industries, including the clothing industry, for balancing assembly lines. However, limited research has been conducted on balancing problems in the clothing industry. Experiments indicate that optimal solutions can be achieved within an acceptable timeframe for small and medium-sized

problems. The use of artificial neural networks and branch-and-bound algorithms have produced favorable outcomes in determining task sequences that minimize cycle time and balance production line disassembly, respectively. The use of meta-heuristics has been effective in evaluating the proposed algorithm for task assignment and minimizing production costs.

CONCLUSION

This review reveals that the implementation of AI techniques in assembly line balancing can significantly reduce production costs, improve workstation utilization, and optimize operator assignment. However, the clothing industry needs to invest in automation technology to increase the level of automation in the assembly phase of manufacturing processes. Further research is required to explore the effectiveness of AI techniques for balancing assembly lines in the clothing industry and address problems involving resource constraints.

REFERENCES

[1] E. W. T. NGAI, S. PENG, P. ALEXANDER, ET K. K. MOON, « Decision support and intelligent systems in the textile and apparel supply chain: An academic review of research articles », Expert Syst. Appl., vol. 41, no 1, p. 81-91, 2014.
[2] D. G. MAHTO ET A. KUMAR, « An empirical investigation of assembly line balancing techniques and optimized implementation approach for efficiency improvements », Glob. J. Res. Eng. Mech. Mech. Eng., vol. 12, 2012.
[3] R. RAMEZANIAN ET A. EZZATPANAH, « Modeling and solving multi-objective mixed-model assembly line balancing and worker assignment problem », Comput. Ind. Eng., vol. 87, p. 74-80, 2015.
[4] P. TAPKAN, L. OZBAKIR, ET A. BAYKASOGLU, « Modeling and solving constrained two-sided assembly line balancing problem via bee algorithms », Appl. Soft Comput., vol. 12, no 11, p. 3343-3355, 2012.
[5] J. PEREIRA, « Modelling and solving a cost-oriented resource-constrained multi-model assembly line balancing problem », Int. J. Prod. Res., vol. 56, no 11, p. 3994-4016, 2018.
[6] B. CAKIR, F. ALTIPARMAK, ET B. DENGIZ, « Multi-objective optimization of a stochastic assembly line balancing: A hybrid simulated annealing algorithm », Comput. Ind. Eng., vol. 60, no 3, p. 376-384, 2011.
[7] M. VILA ET J. PEREIRA, « A branch-and-bound algorithm for assembly line worker assignment and balancing problems », Comput. Oper. Res., vol. 44, p. 105-114, 2014.
[8] S. THOMASSEY ET X. ZENG, Introduction: Artificial Intelligence for Fashion Industry in the Big Data Era. Springer, 2018.
[9] R. ABD JELIL, « Review of artificial intelligence applications in garment manufacturing », Artif. Intell. Fash. Ind. Big Data Era, p. 97-123, 2018.
[10] C. GIRI, S. JAIN, X. ZENG, ET P. BRUNIAUX, « A detailed review of artificial intelligence applied in the fashion and apparel industry », IEEE Access, vol. 7, p. 95376-95396, 2019.

ABSTRACTS OF POSTER PRESENTATIONS

IMPROVING THE FUNCTIONAL PROPERTIES OF WOOL / POLYAMIDE BLEND UPHOLSTERY FABRIC

Yezdan İrem Akgül[1], **Y.Dilek Kut**[2]
[1] *İpekiş Mensucat Türk A.Ş / Demirtaş Organize San. Bölgesi (DOSAB)*
Mustafa Karaer Cad. No:33 16245 Osmangazi / Bursa
[2] *Bursa Uludağ University / Tekstil Müh. Böl. Binası Oda No:504*
yezdanirem.akgul@ipekis.com.tr

Within the scope of the study, it is aimed to improve some functional properties of wool/polyamide upholstery fabrics in line with customer demands. The company has already conducted some development work on these fabrics. Main focus on this research is to produce fabrics with multifunctional properties like water repellent, soil release and flame reterdancy. For this aim, fabrics were treated with fluorocarbon resin (nonionic), organic phosphorus-nitrogen compounds mixture (weak cationic), alkyl phosphonate (uncharged) chemicals. In this application, chemical concentration, application method and chemical types were changed.

As it is known, the wool structure consists of more than one layer and each layer brings in wool fiber different functional properties (Figure 1). The cuticle layer provides water repellency, resistance to pollution, controlled felting, odor absorption, easy removal of sweat to wool fiber. Change in fiber diameter causes to improve a super attitude and drape, softness and comfort and the cortex layer brings in the fiber breathability, porosity, soundproofing, hot-cold heat insulation. Similarly the cell membrane complex affects positively color retention, permanent effect, pleating, permanent abrasion resistance. Flame retardant, hygroscopicity and antistatic properties are gained by matrix structure and finally elasticity and wrinkle resistant, wash and wear feature are due to spiral structure & a-helix structure.

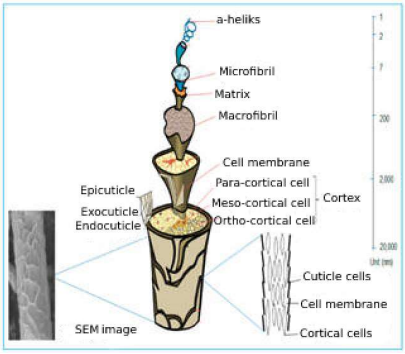


Figure 1. Cross-sectional view of layers of wool
(Kaynak: Faisal Aboelksim Salem Allaf, Journal of Cleaner Production, 2021)

Therefore, the desired properties are tried to be developed in the wool/polyamide fabric in the final processes. After the finishing process applied to the fabric structure, FTIR, SEM, sound absorption analysis, thermal performance analysis, water repellency, combustion behavior, contact angle measurements were conducted, performance and characterization properties were evaluated.

Keywords: Wool, Wool blend fabric, Multifunctionality, Upholstery, Flame Retardent

[1] FAISAL ABOELKSIM SALEM ALLAF&CO. 'Waterless processing of sheep wool fiber in textile industry with supercritical CO2: Potential and challenges', Journal of Cleaner Production, 2021,124819-285.
[2] SHUPIN CHEN&CO., 'Superhydrophobic and phosphorus-nitrogen flame-retardant cotton fabric', Progress in Organic Coatings, 159, 2021, 106446.
[3] PING LI, CHANG LIU& CO., 'Eco-friendly coating based on an intumescent flame-retardant system for
viscose fabrics with multi-function properties: Flame retardancy, smoke suppression, and antibacterial properties', Progress in Organic Coatings, 159,2021, 106400.
[4] SHENGNAN GUO&CO., 'Efficient suppression of flammability in wool fabrics via chelation with ferric ions', Applied Surface Science, 586,2022, 152808.
[5] NABIL A. IBRAHIM&CO., 'Application of MCT-βCD to Modify Cellulose/Wool Blended Fabrics for Upgrading Their Reactive Printability and Antibacterial Functionality', Fibers and Polymers 2018, Vol.19, No.8, 1655-1662.
[6] FATMA ABDELGHAFFAR &CO., 'Functional Antibacterial Finishing of Woolen Fabrics Using
Ultrasound Technology', Fibers and Polymers 2018, Vol.19, No.10, 2103-2111.
[7] NABIL A. IBRAHIM&CO., 'An Eco-Friendly Multifunctional Nano-Finishing of Cellulose/Wool Blends', Fibers and Polymers 2018, Vol.19, No.4, 797-804.
[8] A. HAJI&CO., 'Water Repellent Breathable Pet/Wool Fabrıc Vıa Plasma Polymerısatıon Technology', October 2021TEXTEH Proceedings 2021:74-80.
[9] ANA C. Q. SILVA&CO., 'Natural Polymers-Based Materials: A Contribution to a Greener Future', Molecules 2022, 27, 94. https://doi.org/10.3390/molecules27010094.
[10] A.S. SUBBURAAYASARAN, S. KUBERA SAMPATH KUMAR&CO., 'Comparative Studies on Thermal Comfort

INVESTIGATION OF IMAGE DEFECTS CAUSED BY PILE LOSS OF TOWEL FABRIC

Sultan Aras Elibüyük[1], Mustafa Çörekcioğlu[1], Özlem Demir Günenç[1], Perinur Koptur Tasan[1]

[1]Ozanteks Tekstil, Bozburun Mah., 7042 Sok., No:6, Merkezefendi, Denizli, Türkiye.
saras@ozanteks.com.tr

ABSTRACT

Towel fabrics wear out easily during use. This reduces the usable life of the fabrics. As a result of abrasion, the effect yarn that forms the pile in terry fabrics moves away, causing the ground yarn to become exposed and this causes the appearance of the fabric to deteriorate. For this reason, studies conducted in this field are related to the investigation of the effects of material types and machine parameters on the abrasion resistance of terry fabrics and fabrics created using these pile yarns. In this study, experimental studies have been compiled to determine the wear properties of pile yarns in woven fabric and yarn form in towel products woven with 16/1 cotton yarn upon order within Ozanteks.

Key Words: Towel, Weaving, Pile loss, Pile yarn

INTRODUCTION

Woven fabric production, which is one of the sub-branches of the textile industry, has an important place. Among the woven fabric productions, the use of towels and towel fabrics comes first. Towels are textile products with loop-shaped structures called pile on one or both sides, surrounded by cloth tissue on four sides, in different widths and lengths, in different weights, woven with 3 yarn systems (pile, ground warp and weft). Concepts that are valid only for towels can be expressed as short pile distance, pile height and border [1].

In this study, the reasons for the visual impairment caused by pile loss on the terry fabric produced within Ozanteks Tekstil were investigated. The properties of pile yarns were examined and the test parameters applied to towels produced from these yarns were mentioned. In previous studies within the scope of literature research;

The most distinctive structural feature that distinguishes terry fabrics from others is the pile layer on its surface. In his study, Göksel (1987) introduced the systems that enable pile formation in towel weaving machines and the features that terry fabrics should have. In addition, the structural features that affect the hydrophilicity of towels; It is stated that these are warp density, weft density, pile height and yarn quality (twist amount, fiber type, etc.).

Eren, Alpay and Karahan (2005) introduced the mechanical and electronic pile formation principles with shape support in their study where they examined the pile formation mechanisms in towel weaving machines in detail. It has also been stated that pile and ground warp tension control systems have been developed in terry weaving machines produced in recent years, computer-controlled pile forming mechanisms have begun to be used, and the machine speed can be adjusted to different values in the pile and border sections.

Petrulyte et al. (2013) in their study; pile height of terry fabrics; Its resistance to pile loop removal from finishing operations, impacts and weft density effect was investigated. In his work, terry fabrics produced from linen/cotton and ramie/cotton yarns with a pile structure on both sides were used.

Elmurod and Ganievna, (2021) in their study; The irregularity of pile height length in complex fabrics has been analyzed. In the study, the properties, structures, shapes and stacks of towel samples were examined. The advantages and disadvantages of complex weaves have been investigated.

MATERIALS AND METHODS

In some subcontracted brand towel orders within Ozanteks Tekstil, 100% Cotton yarn is used in its products. When the yarn reaches the factory, the ordered features are checked. All yarns are checked for yarn strength, moisture values, yarn count, thin/thick places, and yarn twist. In addition, the yarn is sent to the testing laboratory in the amount of short fibers it contains.
Within the scope of the study, 10 lots of 16/1 Cotton yarns were selected. The general properties of these yarns were examined within the company.
100% cotton light green colored towel products woven from these yarns were tested for short fiber determination, both washed and unwashed.

RESULTS AND DISCUSSION

The pile yarns of the towel products woven within Ozanteks were tested by the company before they were woven. The test result is given in Figure 1.

Lot	Yarn Number	T/M	Um%	CVm%	Thin +50%	Thin -50%	NEPS +200%	h	RKM	Elongation	Humidity
Lot 1	16/1	650	9,87	12,55	80	7	120	6,98	13,34	6,37	7,7
Lot 2	16/1	650	10,21	12,95	48	2	55	7,11	18,1	5,49	7,8
Lot 3	16/1	650	10,1	12,89	101	3	114	6,75	15	6,44	7,6
Lot 4	16/1	650	10,56	13,69	92	8	200	7,15	13,2	6,33	6,7
Lot 5	16/1	650	9,87	12,58	73	5	45	7,49	17,72	6,47	6,7
Lot 6	16/1	650	10,07	12,8	87	4	157	8,09	16,5	6,39	6,7
Lot 7	16/1	650	10,14	12,91	53	10	98	6,83	15,36	6,4	6
Lot 8	16/1	650	10,23	13,06	55	2	135	6,81	15,2	6,51	9
Lot 9	16/1	650	10,52	13,3	66	8	154	7,69	16,52	6,47	7,7
Lot 10	16/1	650	10,07	12,77	75	5	99	6,97	17,64	6,41	6,7

Figure 1. Results of yarn tests conducted within the company

In the information given in Figure 1, yarn lot number, yarn number, yarn strength, moisture values, thin/thick places, yarn twist checks were made. No problems have been found that pose a problem for production and use. To determine the reason for the loss of pile yarns during use in towel products, light green colored washed and unwashed towels were tested for the amount of short fibers in the pile yarns. The test result is given in Figure 2.

Sample	Color	Type of Yarn	dtex/Flaman	Elongation at break		Strenght		T/m	Fiber		
				%	%Cv	cN/dtex	%Cv		length cm (avrg.)	Min.	Max
Unwashed light green towel	undyed	pile yarn	16/1 Ne	4,1	4,89	0,56	9,31	365	2,3	1,2	3,1
Washed light green towel	undyed		16/1 Ne	3,1	22,33	0,37	18,29	327	1,5	0,8	3

Figure 2. The amount of short fibers in the pile yarns is the test result

As a result of the short fiber amount test of pile yarns in towel products, the average fiber length decreased after washing as per Ozanteks customer requirements.

CONCLUSION

When the loss of appearance due to pile yarn loss in towel products produced within the company is examined, it is seen that the yarn structures do not pose a problem for this production. Towels woven from these yarns went through the dyeing process and were washed domestically. It has been observed that the amount of short fibers in the pile yarns is lost during the use phase. For this reason, after washing, a decrease was observed in the amount of short fibers in the pile yarns of towel products woven from 16/1 cotton yarns. A meeting was held with the company from which the yarn was supplied, and the blending of the yarns was checked. The supplier of the pile yarns used in the towel production phase has been changed.

REFERENCES

[1] ZERVENT ÜNAL, Belkıs. Optimization of The Production Parameters and Performance Properties of Woven Towels. University of Çukurova, Department of Textile Engineering Institute of Natural and Applied Sciencestitle, PhD Thesis, ADANA, 2007
[2] GÖKSEL, İ., 1987. Havlu Dokuma Kumaşların Yapısı. Tekstil ve Teknik Dergisi, 30-36.
[3] EREN, R., ALPAY, H.R., KARAHAN, M., 2005. Havlu Dokuma Makinelerinde Hav Oluşturma Mekanizmaları ve Son Gelişmelerin İncelenmesi. Tekstil&Teknik Dergisi, Sayfa: 270-279, Ocak.
[4] PETRULYTE, S., DAPSAUSKAITE, D., VELICKIENE, A.,AND PETRULIS, D., "Investigation of the Resistance to Pile Loop Extraction of Linen and Ramie Fabrics", Fıbres&Textiles in Eastern Europe, 21, 54-58, (2013).
[5] ELMUROD, M. M. AND GANIEVNA, D. A., "Investıgatıon of The Unevenness of The Pile Heıght Length ın Complex Fabrıcs" General Mechanıcs and Mechanical Engineering, 4(30), (2021).

INVESTIGATION OF RAW MATERIAL SOURCES EFFECT ON GREENHOUSE GAS EMISSIONS IN WOVEN FABRIC MANUFACTURING MILL

Büşra Ardiç Kurt[1], **Gözde Abaci**[2]
[1] *Can Tekstil Entegre Tesisleri ve Tarım Ürünleri San. Tic. A.S. Ergene-2 OSB D-100 No:45/1 59930, Ergene-Tekirdag, Turkiye*
busra.ardic@cantekstil.com.tr

INTRODUCTION

The climate change we are experiencing globally is caused by human factors, an increase in greenhouse gases and particles in the atmosphere, depletion of the ozone layer, and the reckless destruction of the environment. As a result of the studies carried out under the leadership United Nations and international organizations to reduce the negative impact and pressure of humans on the climate, starting from the late 1980s, the United Nations Framework Convention on Climate Change was established in 1992, followed by the Kyoto Protocol in 1997, and the Paris Agreement in 2015. Comprehensive national development policies should be addressed in line with global goals, integration and the need for economic sustainability[1].

The textile industry is among the industries that contribute significantly to greenhouse gas emissions worldwide. These emissions occur in various stages, ranging from the production of raw materials for the sector to the textile product processes and logistics. The current literature on emission calculations in the textile industry has been reviewed within the scope of this study [2]. The effects of greenhouse gas emissions within the scope of climate change, national and international action plans, and innovative and sustainable textile raw material alternatives have been thoroughly examined. The aim of the study is to calculate, validate and investigate the direct and indirect emissions of the existing woven fabric production in an integrated textile operation, as well as explore the impact of innovative and sustainable raw material alternatives on the facility's greenhouse gas emissions.

MATERIAL & METHOD

The study is based on the following standards: TS EN ISO 14064-1 Greenhouse Gases - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals, TS EN ISO 14064-2 Greenhouse Gases - Part 2: Specification with Guidance at the Project Level for Quantification, Monitoring, and Reporting of Greenhouse Gas Emission Reductions or Removal Enhancements, and TS EN ISO 14064-3 Greenhouse Gases - Part 3: Specification with Guidance for the Validation and Verification of Greenhouse Gas Assertions [3, 4, 5]. Detailed field research has been conducted for greenhouse gas emission analysis in an integrated facility involved in woven fabric production. Data flow diagrams have been designed for greenhouse gas emission calculations, and greenhouse gas calculation inventories and annaul data have been prepared. The calculations are based on the reference year 2021 for assessing the impact of emissions from raw materials, and an operational control approach has been followed. The verification process for the calculations has been carried out by the Turkish Standards Institute (TSE) with a reasonable level of confidence. All categories of the standard have been evaluated, except for the ones not applicable within the organizational boundaries, namely Category 1.3: Direct process emissions and removals from industrial processes, Category 1.5: Direct emissions and removals from land use, land-use change, and forestry activities, Category 4.4: Emissions from the use of leased equipment (by the organization), Category 5.4: Emissions from investments and Category 6: Indirect greenhouse gas

emissions from other sources. In contrast to the previous revision of the standard, uncertainty and significance assessments have been completed, and the impact of using different raw materials and alternative sources in the textile industry on greenhouse gas emissions has been examined.

RESULTS AND DISCUSSSION

According to the study, the largest share in the facility's 2021 emission values is attributed to Category 5: Indirect greenhouse gas emissions from the post-production use of products with 62%; followed by Category 1: Direct greenhouse gas emissions and removals (CO2e) with 17%; Category 2: Indirect greenhouse gas emissions from imported energy with 11%; Category 4: Indirect greenhouse gas emissions from products used by the organization with 6%; and Category 3: Indirect greenhouse gas emissions from transportation with 4%. These calculations have been performed and verified.

CONCLUSION

The use of recycled raw materials in woven fabric production reduces process-related greenhouse gas emissions. Sourcing raw materials from the mentioned sources in the production process will contribute to a circular economy in resource consumption and also reduce greenhouse gas emissions in textile woven fabric production. The study encompasses the evaluation of the impact of alternative raw material usage based on verified facility data in the textile sector. All operations/processes associated with textile production, specifically the raw materials used in the fabric production line at the facility's location, have been examined. The comparison of calculations has been conducted to assess the impact of sustainable and/or recycled raw material usage on greenhouse gas reduction.

Keywords: greenhouse gas, carbon emission, textile emission, carbondioxide

REFERENCES

[1] T.C. Ticaret Bakanlığı. (2021). Yeşil Mutabakat Eylem Planı 2021 (Green Deal Action Plan 2021). Available on https://ticaret.gov.tr/data/60f1200013b876eb28421b23/MUTABAKAT%20YE%C5%9E%C4%B0L.pdf

[2] Preffered Fiber & Materials Market Report, October 2022. Available on https://textileexchange.org/app/uploads/2022/10/Textile-Exchange_PFMR_2022.pdf

[3] TS EN ISO 14064-1 Sera Gazları – Bölüm 1: Sera gazı salımlarının ve uzaklaştırmalarının kuruluş seviyesinde hesaplanmasına ve raporlanmasına dair kılavuz ve özellikler, (2019). Turkish Standardization Institue on https://www.tse.org.tr

[4] TS EN ISO 14064-2 Sera gazları - Bölüm 2: Sera gazı salım azaltımlarının veya uzaklaştırma iyileştirmelerinin proje düzeyinde hesaplanması, izlenmesi ve raporlanmasına dair kılavuz ve özellikler, (2019). Turkish Standardization Institue on https://www.tse.org.tr

[5] TS EN ISO 14064-3 Sera gazları - Bölüm 3: Sera gazı beyanlarının doğrulanması ve geçerli kılınmasına dair özellikler ve kılavuz, (2019). Turkish Standardization Institue on https://www.tse.org.tr

DEVELOPMENT OF SUSTAINABLE CONVEYOR BELT FABRIC ALTERNATIVE TO RUBBER CONVEYOR BELTS

Seda Atalay[1], Fehmi Çağlar Balaban[1]
[1] *Zorluteks Textile Trade and Industry Inc./ R&D Department / Turkey*
seda.atalay@zorlu.com

Conveyor belt systems are transport equipment used to transport materials from one place to another in any facility [1]. These systems have advantages such as efficiency speed, long transportation distances, low energy consumption, operational safety, and simple operation and maintenance compared to other transportation vehicles [2]. In the research, it is seen that the transportation of materials in a convenient way in terms of energy, time, and money has a direct effect on the economy of the enterprise [3]. Due to the increase in the traffic density of the material flows of the production facilities, conveyor belts are accepted as the most efficient and effective solution preferred by enterprises both in terms of economy and ease of use [4].

Conveyor belts are produced from rubber today. Conveyor belts are produced from natural, isoprene, butadiene, styrene, butadiene, and rubber varieties [6]. These rubber materials, which have completed their useful life, bring along a serious waste problem. Today, many studies are carried out on the recycling of waste rubber, which is very difficult and laborious to recycle. In the study of Adhikari et al., cheap, non-toxic chemicals recycled from plant products have been developed for the recycling of waste rubbers [6].

It is noteworthy that the proportion of plastic and rubber wastes in the environmental pollution caused by humans around the world is high, and today, conveyor belts are preferred more in many areas such as loading, unloading, stockpiling, and taking from stock in the material transportation. Thus, usage rates increase, and conveyor belts that have expired cause environmental pollution. Conveyor belts, as a result of insufficient strength, rupture, puncture, tear, etc. reasons cause the end of their useful life. Damage to conveyor belts for any reason is considered a great risk, as it hinders production in enterprises as well as environmental pollution [7]. For this reason, high strength, long working life, and resistance to bending are what is expected from the conveyor belt.

The aim of this study is to develop fabrics that can be used in the production of high-strength conveyor belts with different construction design studies. These fabrics will be produced on the weaving machine and will offer a more sustainable alternative to rubber conveyor belt production. In addition, thanks to its high strength, products with a high service life will be developed.

Within the scope of the study, multifilament polyester yarns with high strength and low dry air shrinkage will be woven in Sulzer brand weaving machines. The work plan created within the scope of the study is given in Table 1.

Table 1. Work Plan

Experiment Number and Name	Experiment
1. Design studies	Determination of pattern design with EAT software
2. Process Parameters	1. Warp Tension
	2. Beam Tension
3. Construction Design Studies	1. Warp Yarn
	2. Weft Yarn
	3. Warp-weft density
	4. Fabric Type

In order to develop high-strength and anti-static fabrics produced according to this study plan, it was preferred to use plain weave type, which is a unique construction weave. As a result of the experimental study, the tensile strength, weight determination, hot air, skewness, and bow fabric tests were performed and the sample performances were evaluated. TS EN ISO 13934-1.2013 standards were used to determine the breaking strength and elongation properties of the produced sample. The test results performed according to this standard are shown in Table 2.

Table 2. Tensile Strength Test Results

Sample Number	Tensile Strength (N/S cm) (TS EN 13934-1:2013)		Elongation at Break (%) (TS EN ISO 13934-1:2013)	
	Warp	Weft	Warp	Weft
1	≥4300	≥1500	≥20	≥20
2	≥3900	≥1400	≥20	≥20
3	≥4700	≥3000	≥20	≥20
4	≥5700	≥1000	≥20	≥20

The weights of the produced samples were measured according to the UNI 5114 standard. Test results are shown in Table 3.

Table 3. Weight Measurements

Sample Number	Weight (gsm) (UNI 5114)
1	270 (±5%)
2	270 (±5%)
3	350 (±5%)
4	565 (±5%)

The hot air shrinkage test of the fabric samples produced was measured according to the DIN EN 14621 standard. Test results are given in Table 4.

Table 4. Hot Air Shrinkage Test Results

Hot Air Shrinkage Test (180 C 15 mins) (%) (DIN EN 14621)	
Warp	Weft
2,5	1,5
2,5	1,5
2,5	2,5
2,5	

The skewness and bow fabric tests of the fabric samples produced were measured according to ASTM D 3882-2008 standards. Test results are given in Table 5.

Table 5. Skewness, Bow Fabric Test Results

Skewness (%) (ASTM D 3882:2008)	Bow Fabric (%) (ASTM D 3882:2008)
0± 3	0± 3
0± 3	0± 3
0± 3	0± 3
0± 3	0± 3

According to the test results applied to the fabrics woven in different constructions, trial No. 1 can be used for belts made for conveying systems generally, Trial No. 2 is expected to provide static electricity resistance in the conveying systems, Trial No. 3 is used for bands with the expectation of flexibility in the direction of width in conveying systems, and Trial No. 4 shows that it can be used in power transmission elements in machines.

Keywords: Conveyor Belt, High Strength, Construction Design

[1] SOLAK, A. Design of belt conveyor for coal mines and optimization of design parameters. Institute of Science Technology, thesis, 2017.
[2] FICZERE, P., ULTMANN, Z., and TÖRÖK, A., Time-space analysis of transport system using different mapping methods," Transport, vol. 29, no. 3, pp. 278–284, 2014.
[3] DEMIR, M. Yüksek sıcaklıkta çalışan bantlı konveyörler. Yıldız Teknik Üniversitesi Fen Bilimleri Fakültesi, 2006.
[4] L., P., ALVIARI, M., F., ANGGAMAWARTI, Y., SANJIWANI, V., Y., RISONARTA, ''Classification of Impact Damage on A Rubber-Textile Conveyor Belt: A Review, International Journal of Mechanical Engineering Technologies and Applications, no. 4, pp. 21-27, 2020.
[5] H., SAVRAN, Elastomer teknolojisi-I, Acar Matbaacılık, İstanbul.
[6] B., De., D., ADHİKARİ, S., MAİTİ, Reclamation, and recycling of waste rubber, Progress in Polymer Science, 25, 909-948.
[7] G. FEDORKO et al. ''Failure analysis of conveyor belt samples under tensile load'', Journal of Industrial Textiles, vol. 48(8), 1364-1383, 2019. doi: 10.1177/1528083718763776

SLOW FASHION AND MODULAR DESIGN: IMPROVE SUSTAINABILITY AND VERSATILITY IN TEXTILE PRODUCTS

Simge Bölük[1], **Gökçe Deniz Gür Güvenç**[1], **Şeyda Kesici**[1]
[1]*TYH Textile R&D Center, İzmir, Türkiye*
seydakesici@tyh.com.tr

ABSTRACT
In recent years, textile design has become a focal point in the textile and apparel industry, with professionals creating designs that prioritize visuality, including fabric, color, pattern, accessory, and more. However, the ever-changing and increasing needs of consumers have also led to the spread of fast fashion. This increase in demand has also caused diversity in textile designs. This study explores textile and garment designs from various perspectives, focusing on visuality and the production of sustainable products that offer alternative options for consumers. Thus, within the scope of sustainable fashion, designers create versatile designs that individuals can wear and use in different ways. Reducing environmental damage, increasing sustainable production, and promoting slow fashion are the objectives of this study.

INTRODUCTION
Garment production is one of the leading sectors that produce environmental pollution. The increasing population and fast fashion have caused a rapid increase in production and consumption [1]. Short-term or long-term changes in apparel create fashion trends, and these trends have increased consumption and introduced the concept of fast fashion. [2]. The term fast fashion means continuous production, which is carried out to meet the needs of consumers who want to wear new and different products. Consumers want to wear new garments all the time, along with manufacturers' ambition to produce and profit, which results in rapid resource consumption and damage to the environment. [3].
Sustainability is essential for the textile and fashion industry, which is one of the most important consumer industries serving people's clothing, protection, and dressing needs. Various approaches are being developed to mitigate the negative environmental effects of fast consumption and increase awareness of sustainable production, such as pattern designs that do not waste fabric, modular pattern applications, timeless designs, and longer product use [4]. Slow fashion encourages sustainability by emphasizing factors other than material use and production [5]. Although the use of sustainable methods is instructive, the production of sustainable products is costly. To bring a solution to this, it is aimed to design products that allow multi-purpose and long-term use.
Modular design comes into effect when the body measurements used by different companies in different nations do not conform to a single standard [6, 7]. Modular designs allow not only a change in the way of using products but also the use of individuals of different ages, genders, and body sizes. With modular designs, it is aimed that individuals with different body sizes living in the same house can use a single outfit in different ways. Thus, it will be possible to produce sustainable products by contributing to the environment and using the products for a long time in different functions.

MATERIAL AND METHOD
In this study, 100% cotton fabric with a weight of 420 g/m2 and 5 g metal zippers were used for modular designs. The fabric colors selected for the collections were not based on features such as age, gender, or size. The selected metal accessories were chosen for their suitability with the

designs and ability to provide user comfort. Trend analyses for design ideas were performed in the preliminary study, and how they could be employed in product groups within the company was studied. The design process began with sketches based on the research findings. Accessory research was also carried out to ensure suitability with the selected designs. The patterns were created using 2D software, ensuring that they were wearable, suitable for the company's product groups, and not dependent on factors such as age, gender, and size. Since the designs are aimed to be used regardless of gender, age and size, they have been developed for the use of at least two people. Browzwear V-Stitcher software was used in the digital sample production process in this study. The 3D productions used 301-SN and 406 1/8"gg DNTS sewing techniques. Heat maps were used in the design process of the models to ensure user comfort.

RESULTS AND DISCUSSION

Figure 1. Model 1 hoodie first and second alternative usage and heatmaps

CONCLUSIONS

The modular designs produced are innovative and environmentally friendly products suitable for individuals of varying ages, genders, and body sizes. These designs enable a single product to be utilized in various creates and for an extended period. With its modular usage, a range of slow fashion-inspired sustainable clothing goods was obtained that provides at least twice the use of similar products produced using traditional methods.

Keywords: Modular clothes, sustainable fashion, functional clothing, slow fashion

REFERENCES

[1] ALTINBAŞ, G. N., & CAN, D. İ. Sürdürülebilirlik Temelinde Bedensiz ve Dönüşebilen Kıyafetler.
[2] ERTÜRK, N. (2011). Moda kavramı, moda kuramları ve güncel moda eğilimi çalışmaları. Art-e Sanat Dergisi, 4(7), 1-32.
[3] YÜKSEL, B. H. G. C. Moda Sektörünü "Yavaşlatan" Eğilim: Eko Moda ve Moda'da Sürdürülebilirlik. Akdeniz Sanat, 4(8).
[4] ESER, B., ÇELIK, P., ÇAY, A., & AKGÜMÜŞ, D. (2016). Tekstil Ve Konfeksiyon Sektöründe Sürdürülebilirlik Ve Geri Dönüşüm Olanaklari. Tekstil ve Mühendis, 23(101), 43-60.
[5] LANGDOWN, A. (2014). Slow fashion as an alternative to mass production: A fashion practitioner's journey. Social Business, 4(1), 33-43.
[6] CHUN-YOON, J., & JASPER, C. R. (1993). Garment-sizing Systems: An International Comparison. International Journal of Clothing Science and Technology, 5(5), 28-37.
[7] CHUN, J. (2014). International apparel sizing systems and standardization of apparel sizes. In Anthropometry, apparel sizing and design (pp. 274-304). Woodhead Publishing.

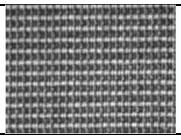
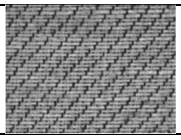
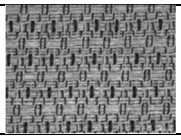
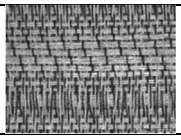
INFLUENCE OF THE WEAVING STRUCTURE PARAMETERS ON THE WETTABILITY OF THE LINEN FABRICS

Nina Čuk[1], **Klara Kostajnšek**[1], **Matejka Bizjak**[1], **Barbara Simončič**[1], **Brigita Tomšič**[1]
[1] *University of Ljubljana, Faculty of Natural Sciences and Engineering, Aškerčeva cesta 12, 1000 Ljubljana*
nina.cuk@ntf.uni-lj.si

Linen fabric, one of the oldest known fabrics ever, is made from flax, a sustainable, stiff and naturally lustrous fibre [1]. The majority of linen fabrics are used for apparel, followed by table and kitchen wear, towels, and other uses. The average annual growth rate between 2021 and 2029 is estimated to be 3% [2], which is mainly due to the sustainable advantages of flax, as it does not require many chemicals and irrigation during cultivation [1]. Flax fibres are mainly composed of α-cellulose [3], which ensures the hydrophilicity of the fibres due to the many - OH groups. However, the wettability and thus the water transfer behaviour is not only influenced by the chemical structure, but also strongly by the weaving structure and the associated porosity of the fabric, the thread density, the weave, and the thickness [4]. The aim of the study was therefore to evaluate the influence of the weaving structure parameters on the wettability of the linen fabric.
For the study four different weaves (plain, satin, cross twill, and shaded) were produced on the Minifaber laboratory loom (Minifaber Spa, Italy) with electronic jacquard TIS. 100% optically bleached and starched cotton thread (2 x 8 tex) was used as warp thread and 100% linen thread (53 tex) as weft thread. The weft density on the machine was always set to the maximum value that the loom can weave with a simple warp/fabric movement control mechanism, while the warp density for all samples was 40 threads/cm.

Microscopic images were taken with a stereomicroscope (Leica Microsystems GmbH, Wetzlar, Germany, DE) at 61× magnification. Thickness was measured according to SIST EN ISO 5084, while mass per unit area was measured according to SIST EN 12127. Porosity was measured by the Jakšić method [5], and surface openness was determined using the ImageJ program. Air permeability measurements were performed on MESDAN-LAB, B.A.P. 37/S, according to the standard ISO 9237:1995. The thin-layer wicking (TLW) was determined in the weft direction according to Chibowski [6] to evaluate the wettability of the studied fabric samples.

Table 1. Structural and measured properties of the linen fabric.

Properties/**Weave**	**Plain**	**Satin**	**Cross twill**	**Shaded**
Stereomicroscopic images				
Weft density (threads/cm)	14.00	18.00	25.00	22.00
Thickness (mm)	0.533 ± 0.003	0.658 ± 0.003	0.856 ± 0.010	1.023 ± 0.016
Mass per Unit Area (g/m²)	155.32 ± 1.89	184.40 ± 1.38	231.80 ± 1.16	226.64 ± 2.33
Bubble point (µm)	130.00	138.00	144.00	253.00
Mean pore diameter (µm)	29.50	42.40	32.36	64.58
Surface openness (%)	19.15	13.18	10.54	11.54
Air permeability ($cm^3/cm^2/s$)	100.11 ± 0.64	137.83 ± 0.86	88.20 ± 0.81	181.91 ± 2.94

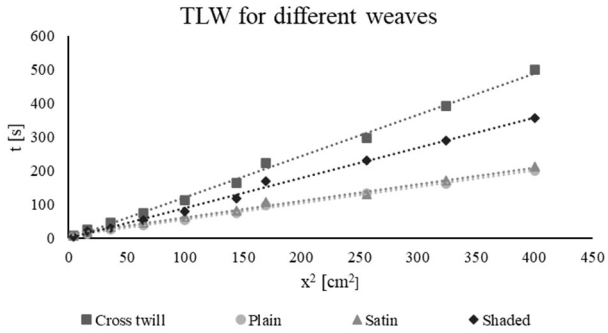


Figure 1. Results of thin-layer wicking test (TLW)

From the results (Table 1) a very high positive correlation between bubble point and mean pore diameter (0.94) and between mean pore diameter and air permeability (0.97) was determined, while, on the other hand, a very high negative correlation was found between surface openness and mass per unit area (-0.94) and between surface openness and weft density (-0.94). The plain and satin weave fabric samples with the lowest weft density, thickness, and mass per unit area had the highest wettability (Figure 1), while water penetration rate was lowest for the cross twill and shaded weave fabric samples with the highest weft density, thickness, and mass per unit area. While the fabric samples in cross twill, satin and plain weave had a fairly similar bubble point, the openness of the surface decreased in the following order: plain > satin > shaded > cross twill weave. Accordingly, high positive correlation between water penetration rate and mass per unit area (0.90) as well as between water penetration rate and weft density (0.94) was determined, whereas between water penetration rate and surface openness a negative correlation (-0.77) was obtained.

It can be concluded that the weaving structure parameters have an important influence on the water permeability and thus on the wettability of the linen fabric, with the weft density, mass per unit area and surface openness of the fabric samples studied being of greater importance than other tested parameters.

Keywords: linen fabric, weaving structure parameters, wettability, porosity

[1] Textilepedia. Hong Kong: Fashionary International Ltd, 2020, p 239.
[2] Linen Fabric Market: Global Industry Analysis and Forecast (2022-2029) Dynamics, Opportunities, Restrictions, Segmentation by Type, Application, and Region [online], [cited 27.06.2023]. Available on https://maximizemarketresearch.com/market-report/global-linen-fabric-market/85858/
[3] ANSARI, I.A., EAST, G.C., JOHNSON, D.J. Structure-properties relationships in natural cellulosic fibres: Part I characterization. Journal of the Textile Institute, 1999, vol. 90, no. 4, pp 469–480.
[4] LEI, M., LI, Y., LIU, Y., MA, Y., CHENG, L., HU, Y. Effect of Weaving Structures on the Water Wicking–Evaporating Behavior of Woven Fabrics. Polymers, 2020, vol. 12, no. 2, pp 1–12.
[5] JAKŠIĆ, D., JAKŠIĆ, N. Assessment of porosity of flat textile fabrics. Text. Res. J., 2007, vol. 77, pp 105–110.
[6] CHIBOWSKI, E., GONZÁLEZ-CABALLERO, F. Theory and Practice of Thin-Layer Wicking. In Langmuir, 1993, vol. 9, pp 330–340.

HEMP AND COTTON AS A NATURAL FIBER

Pınar Çelik[1], Ayşegül Körlü[1], Aslı Şahiner[2], Hüseyin Özay[2]
[1] *Ege University / Engineering Faculty / Textile Engineering Department, Bornova-Izmir*
[2] *Ege University / Faculty of Science / Department of Biology, Bornova-Izmir*
pinar.celik@ege.edu.tr

With the concept of sustainability gaining importance worldwide, the textile industry started to attract more attention because the textile industry is one of the most polluting industries in the world. Depending on the increase in environmental problems worldwide, the methods of obtaining textile raw materials have also become important. Accordingly, the search for a more environmentally friendly textile fiber has begun. Therefore, in this study, among the fibers that are the raw materials of textiles, cotton fibers, which have been considered white gold for many years due to both production and consumption, will be compared with hemp fibers, which have been popular in recent years. Hemp and cotton, both vegetable fibers, differ in their cellulose and other substance contents and the region from which the plant is obtained (Table 1) [1].

Table 1. Chemical composition and mechanical properties of cotton and hemp fibers. [1]

	Cotton fiber	**Hemp fiber**
Origin of plant fibers	Seeds fibres	Bast fibers
Cellulose (%)	82.20-90.00	70.20-74.40
Lignin (%)	-	3.70-5.20
Hemicellulose (%)	3.00	17.90-22.40
Pectin (%)	-	0.90
Wax (%)	0.60	0.80
Moisture (%)	7.85-8.50	6.20-12.00
Ash (%)	-	0.80
Microfibrillar angle (°)	-	2.00-6.20
Density (g/cm^3)	1.48-1.60	1.40-1.50
Elongation at break (%)	2.00-10.00	1.00-4.00
Tensile strength (MPa)	287-800	270-1110
Elastic modulus (GPa)	5.50-13.00	3.00-90.00

Cotton is the highest-produced natural fiber. However, its cultivation needs intensive water consumption and chemicals such as pesticides and fertilizers [2, 3, 4]. The production of fibre must be less harmful to the environment and economical. Duque Schumacher et al. (2020) compared cotton and hemp fibers. They used four data for comparison: fertilization costs, seed costs, water consumption, and pest control cost. They used these costs and fiber yield to estimate final fiber production in USD per metric ton. According to their result, industrial hemp fiber was better than cotton regarding economic and environmental friendliness.

According to cotton, hemp as a crop has some advantages [5]. After 3-4 months from planting, hemp is ready to be harvested [6]. When compared to the ecological footprint of both fibers, hemp fiber has lower values (1.46 - 2.01 gha) than cotton fiber values (2.17 - 3.57 gha) [2, 7].

Keywords: Hemp, cotton, sustainability, natural fiber

[1] CHOKSHI, S., PARMAR, V., GOHIL, P., CHAUDHARY, V. Chemical Composition and Mechanical Properties of Natural Fibers, Journal of Natural Fibers, 2022, 19:10, pp.3942-3953, DOI: 10.1080/15440478.2020.1848738

[2] DUQUE SCHUMACHER, A.G., PEQUITO, S., PAZAOUR, J.SURNAME, N. Industrial hemp fiber: A sustainable and economical alternative to cotton. Journal of Cleaner Production, 2020, 268, 122180, https://doi.org/10.1016/j.jclepro.2020.122180.
[3] FRANCO, M.A., Circular economy at the micro level: a dynamic view of in-cumbents' struggles and challenges in the textile industry. J. Clean. Prod. 2017, 168, 833e845. https://doi.org/10.1016/j.jclepro.2017.09.056SURNAME,
[4] SANDIN, G., PETERS, G.M., Environmental impact of textile reuse and recycling - a review. J. Clean. Prod. 2018, 184, 353e365. https://doi.org/10.1016/ j.jclepro.2018.02.266
[5] https://hempfoundation.net/a-comparative-of-hemp-fiber-and-cotton-fiber/ (online available 25.07.2023)
[6] https://sustainabilityscout.com/hemp-fabric-vs-cotton-and-bamboo-how-sustainable-is-it/ (online available 25.07.2023)
[7] CHERRET, N., BARRET, J., CLEMETT, A., CHADWICK, M., CHADWICK, M.J. Ecological Footprint and Water Analysis of Cotton, Hemp and Polyester. BioRegional Development Group and WWF Cymru, 2005, Stockholm Environment Institute, ISBN 91 975238 2 8.

DEVELOPMENT OF MULTIFUNCTIONAL OUTDOOR FABRICS USING ACRYLIC YARN

Özlem Demir Günenç[1], Mustafa Çörekcioğlu[1], Perinur Koptur Tasan[1], Sultan Aras Elibüyük[1]

[1]Ozanteks Tekstil, Bozburun Mah., 7042 Sok., No:6, Merkezefendi, Denizli, Türkiye.
ozlem.demir@ozanteks.com.tr

Upholstery fabrics have a significant share in home textile production, and durability and aesthetics are the most important parameters [1]. In addition, upholstery fabrics can be made functional by giving them different finishes according to the place of use and the desired performance properties. Acrylic fibers are frequently used in the production of products that have durability and aesthetic importance, such as upholstery fabrics [2].

In this study, information about upholstery woven fabrics, production techniques and applied performance tests was given, and the mechanical properties of the upholstery fabrics produced as samples were examined. The fabrics are woven as outdoor fabrics in different colors and designs using 100% acrylic solution-dyed dyed acrylic yarn.

100% Acrylic solution dyed yarns were supplied in the specified colors, and the fabrics were woven by patterning according to the colors. A water-repellent finish is applied to the woven fabrics. In this way, the oil and dirt repellent properties of the fabric are provided at the same time, as it will not cling to the fabric due to its water repellent and repellency properties. A comparison of fabrics produced with a reference fabric with similar properties was made.

Firstly, the weight determination of the woven fabrics was made according to the TS 251/EN ISO 3801 standard. Fabric weight is measured as 250 g/m^2. The weight of the reference fabric is 256 g/m^2.

Then, washing fastness (ISO 105-C06) and rubbing fastness (TS EN ISO 105-X12) [Table 1] tests were applied to the fabrics. Washing and rubbing fastness results were excellent.

Table 1. Results of washing fastness

	Color fastness to washing (ISO 105-C06)						Color fastness to rubbing (TS EN ISO 105-X12)	
	Wool	**Acryclic**	**Polyester**	**Nylon**	**Cotton**	**Acetate**	**Wet rubbing fastness**	**Dry rubbing fastness**
Blue	5	5	5	5	5	5	4-5	5
Squared	5	5	5	5	5	5	5	5
Blue-Grey	5	5	5	5	5	5	4	4-5
Grey-White	5	5	5	5	5	5	5	5
Yellow-White	5	5	5	5	5	5	5	5
Grey-White-Yellow	5	5	5	5	5	5	5	5
Reference sample	5	5	5	5	5	5	5	5

One of the desired properties when determining fabric quality parameters is tensile and tear strength. When the rupture and tear strengths of the samples were compared with the reference sample [Table 2], the same values were reached.

Table 2. Results of tensile and tear strength

	Tensile strength (ISO 139-34-1)		Tear strength (ISO 13937-2)	
	warp	weft	warp	weft
Sample	1092	708	44	35
Reference sample	1091	765	37	27

The most important feature required from upholstery/outdoor fabrics is that the fabric is water repellent. Water repellency values of sample fabrics were measured. When the results are examined [Table 3], it is seen that the water repellency values are at an acceptable level.

Table 3. Results of water repellency and light fastness

	Water Repellency (Original)[1]ISO 4920:2012
Sample	2-3.

In addition, the result of the light fastness test, which is another important desired feature, was also acceptable [Table 4].

Table 4. Results of light fastness

	Light fastness(ISO 105 B02)
	blue scale
Grey-White-Yellow	4

When the results of the tests are examined, it is seen that the fabric produced within our company meets all the expectations expected from outdoor fabric. At the same time, although there are different studies as a result of literature studies, there is no research on the finishing and testing applications of the 100% acrylic woven fabrics included in the project. This study will also contribute to the literature. In addition, it will be an original work as a collection containing different designs will be prepared from the fabrics resulting from the project. Since collectible products also have commercialization potential, they will increase the competitiveness of the company and create export potential.

Keywords: Outdoor fabric, akrilik, upholstery fabric

[1] EREM, A.D. Döşemelik kumaşların kullanım performanslarını ve aşınma dayanımlarını etkileyen şönil iplik parametrelerinin incelenmesi. İstanbul Teknik Üniversitesi: yüksek lisans tezi, 2006.
[2] YAVAŞCAOĞLU, A. Akrilik karışımlı ipliklerden dokunmuş kumaş özelliklerinin araştırılması. Bursa Uludağ Üniversitesi: yüksek lisans tezi, 2018.

ANTIBACTERIAL PROPERTIES OF NEEDLE-PUNCHED NONWOVENS FOR MEDICAL APPLICATIONS

Ege Ertoğrul[1], Hatice Aktekeli Yılmaz[1], Işık Özgüney[2], Deniz Duran Kaya[3]
[1] *Ege University / Graduate School of Natural and Applied Sciences / Textile Engineering /*Bornova-IZMIR
[2] *Ege University / Department of Pharmaceutical Technology / Faculty of Pharmacy /Bornova-IZMIR*
[3] *Ege University / Faculty of Engineering / Textile Engineering /*Bornova-IZMIR
ertogrulege@gmail.com

In wound treatment, it is of great importance for the healing process to absorb the exudate from the wound and to prevent the risk of infection. In the study, the layer that will form the absorbent layer, suitable for medical use, was produced as a non-woven surface by using hydrophilic and antibacterial fibres, obtaining web from combs, and fixing by needling.

Needle-punched process is after bale opening and blending, the fibres are fed to the combs in the mechanical fixation method by needling and obtaining web from combs that allow the processing of synthetic and natural fibres. After combing, the obtained web is laid on top of the web laying and folding band by the camel neck according to the desired thickness. Then, continuous needling is applied to the formed fibre web. Notched needles move the fibres from one side of the web to the other, creating a complex structure. Some of the fibre forming the web, which is in a loose state during needling, goes up by attaching to the needles, while the other part stays in place. In this way, the mechanical bonding of the fibres to each other is achieved. The schematic representation of the production of web from comb that allow the processing of synthetic and natural fibres and the mechanical fixation method by needling are given in Figure 1. (Duran, 2004).

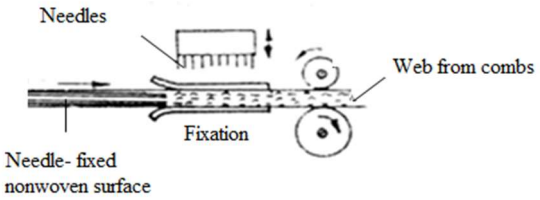


Figure 1. Schematic representation of the needle-punched process

The first of these is that the nonwoven surface production with these methods does not contain any additives, and the surface is produced directly with the help of fibres and combs and needles. This is of great importance for medical textiles. The second advantage is that this method creates a soft, bulky, porous, absorbent, and stable structure that can absorb the exudate, allow the wound to breathe during healing, and provide comfort to the wearer. In addition, the structure produced will create a soft buffer against the impacts that may come from the outside, thanks to its voluminous feature.

5 types of samples were produced to use viscose fibres containing 100% Viscose, 100% Chitosan, 10%, 20% and 30% Chitosan. While Viscose fibres provide absorbent properties to the structure, chitosan fibres are the fibres preferred in medical applications in recent years, since they have both hydrophilic and bacteriostatic properties.

Hydrophility and antibacterial analyses were carried out on the obtained surfaces. The analysis results showed that the 5 samples have hydrophilic and antibacterial properties.

5 surfaces produced have hydrophilic properties, but the increase in the amount of chitosan in the structure prolonged the absorption of the liquid dripped onto the surface.

When the literature is examined, it has been reported that chitosan is more hydrophilic than viscose. However, chitosan has a structure containing repetitive functional groups containing two hydroxyls and one amino due to its structure. The presence of surface functional groups made chitosan a pH sensitive material. In addition, chitosan exhibited hydrophobicity at higher pH values, while resulting in a more hydrophilic nature at low pH values, as a function of the protonation intensity of amino groups in the acidic environment (de Alvarenga, 2011). In addition, surface contamination of chitosan may explain its less hydrophilic nature than viscose.

Keywords: Needle punching, Medical Textile, Chitosan, Antibacterial Textile

This study is supported by TUBITAK 122M049 project as a part of the Scientific and Technological Research Projects Funding Program (1001).

[1] DURAN, K.,2004, Dokusuz Yüzeyler (1. Basım). İzmir: Teknik Yayınevi.
[2] DE ALVARENGA, E. S. (2011). Characterization and properties of chitosan. Biotechnology of biopolymers, 91, 48-53.

Ag, TiO_2 AND GRAPHITIC CARBON NITRIDE COMPOSITES FOR THE PREPARATION OF PHOTOCATALYTICALLY ACTIVE COTTON FABRIC

Dominika Glažar[1], Tomaž Žigon[1], Brigita Tomšič[1], Danaja Štular[1,2], Mohammad Mamunur Rashid[1], Ivan Jerman[2], Raghuraj Singh Chouhan[3], Barbara Simončič[1]

[1] Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Aškerčeva 12, 1000 Ljubljana, Slovenija
[2] Kemijski inštitut, Hajdrihova 19, 1000 Ljubljana, Slovenija
[3] Institut "Jožef Stefan", Jamova cesta 39, 1000 Ljubljana, Slovenija
dominika.glazar@ntf.uni-lj.si

Synthetic dyes in textile wastewater represent one of the major contaminants. Various physical, chemical and biological processes are used for their removal, among which semiconductor-based photocatalysis is one of the most environmentally friendly processes as it degrades dyes to water and CO_2 [1]. Therefore, the aim of the research was to synthesise Ag/TiO_2 and Ag/graphitic carbon nitride (gCN) and TiO_2/gCN composites and use them for chemical modification of cotton (CO) fabric to study the photodegradation process of Rhodamine B (RhB) dye in aqueous solution. It was assumed that the developed photocatalytically active CO would successfully decolorize the RhB dye solution.

In the experiment, Ag/TiO_2, Ag/gCN and TiO_2/gCN composites were synthesised at 20 °C from $AgNO_3$ (1.0 mM), titanium(IV) isopropoxide (3.0 %) and previously synthesised gCN (0.5 %) in a water/isopropanol solution in the presence of ascorbic acid and ethanoic acid as reducing agents. They were applied to 100 % CO fabric by the pad-dray-cure method to prepare CO(Ag/TiO_2), CO(Ag/gCN) and CO(TiO_2/gCN) samples. For comparison, single-component Ag, TiO_2 and gCN were also applied to CO under the same conditions to prepare CO(Ag), CO(TiO_2) and CO(gCN) samples. In addition, TiO_2/gCN was synthesised at 70 °C keeping the other conditions and applied to CO to prepare the CO(TiO_2/gCN-70) sample. The photocatalytic activity of the samples was investigated by determining the decolorization rate of the RhB dye solution when illuminated with a xenon lamp.

The results (Figure 1a) show that CO itself is not photocatalytically active. Among the chemically modified samples, the CO(gCN) sample exhibits the lowest photocatalytic activity, which is due to the fast charge recombination and low charge mobility of gCN. Doping gCN with Ag (CO(Ag/gCN) sample) improves the photocatalytic activity as electrons (e^-) can be transferred from the conduction band (CB) of gCN to Ag (Figure 1b), creating a Schottky barrier that reduces the charge recombination [2]. The separated e^- in Ag can react with O_2 to form reactive oxygen species (ROS), and holes (h^+) in the valence band (VB) of gCN can directly oxidize pollutants, which increase the photocatalytic efficiency. In contrast, doping TiO_2 with Ag decreases the photocatalytic activity of TiO_2, as the CO(Ag/TiO_2) sample slower decolorizes the RhB dye than the CO(TiO_2) sample (Figure 1a). This indicates that the synthesis route of the composite significantly affects its photocatalytic performance. In contrast to the synthesis of Ag/gCN, where Ag was synthesized on the surface of previously synthesized gCN, both components of the Ag/TiO_2 composite were synthesized simultaneously. The highest photocatalytic efficiency obtained for the CO(TiO_2/gCN) sample (Figure 1a) confirms the excellent photocatalytic performance of the semiconductor heterojunction, which follows the direct Z-scheme mechanism (Figure 1c). In this case, e^- in the CB of TiO_2 and h^+ in VB of gCN with lower redox power are

recombined, while ROS are formed in more energetically favourable CB of gCN and VB of TiO_2 [3]. The additional increase in the decolourization rate of RhB dye in the presence of CO(TiO_2/gCN-70) sample confirms that the synthesis of the composite at the higher temperature improves the photocatalytic performance of TiO_2/gCN heterojunction.

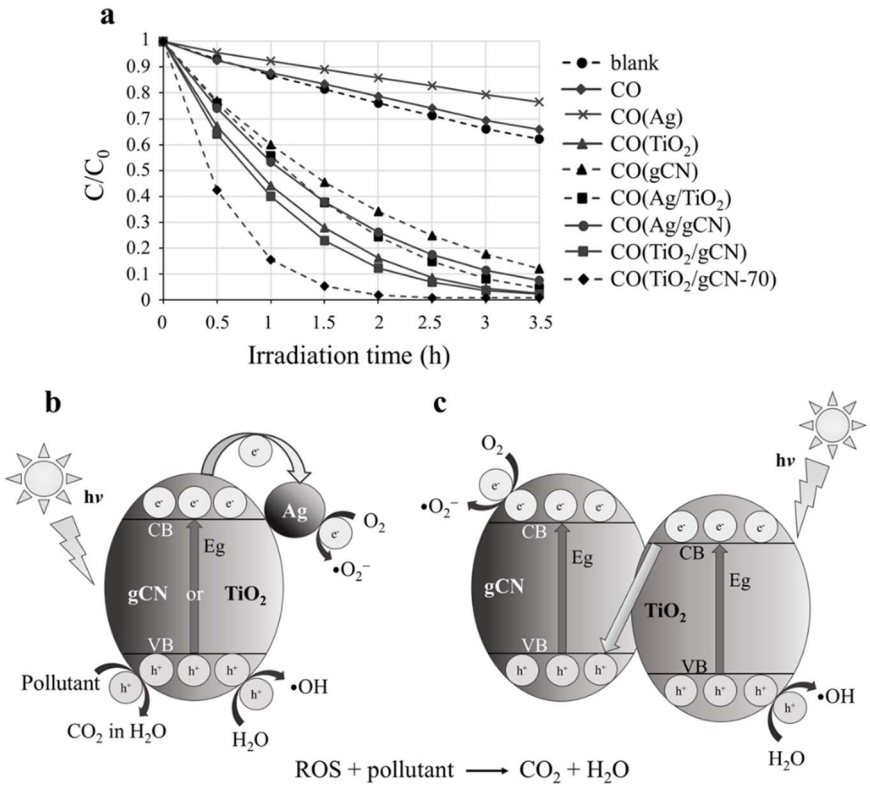


Figure 1. Photocatalytic degradation of RhB under a xenon lamp at different irradiation times (a), the photocatalytic mechanism of Ag/TiO_2 or Ag/gCN composites (b) and TiO_2/gCN composite (c) under illumination with UV and VIS light

From the results it can be concluded that both the synthesis route and the mechanism of photocatalytic action have a significant influence on the effectiveness of the photocatalytic performance of the composite and thus on the decolourization rate of the RhB dye solution.

Keywords: cotton, Ag/TiO_2, Ag/gCN, TiO_2/gCN, photocatalytic dye degradation

[1] AL-BURIAHI, A.K., AL-GHEETHI, A.A., SENTHIL KUMAR, P., RADIN OHAMED, R.M.S., YUSOF, H., ALSHALIF, A.F. and KHALIFA, N.A. Elimination of Rhodamine B from textile wastewater using nanoparticle photocatalysts: A review for sustainable approaches. Chemosphere, 2022, 287.
[2] KHAN, M.R., CHUAN, T.W., YOUSUF, A., CHOWDHURY, M.N.K. and CHENG, C.K. Schottky barrier and surface plasmonic resonance phenomena towards the photocatalytic reaction: Study of their mechanisms to enhance photocatalytic activity. Catalysis Science and Technology, 2015, 5, 2522–2531.
[3] XU, Q., ZHANG, L., YU, J., WAGEH, S., AL-GHAMDI, A.A. and JARONIEC, M. Direct Z-scheme photocatalysts: Principles, synthesis, and applications. Materials Today, 2018, 21, 1042–1063.

DESIGN AND DEVELOPMENT OF A JACQUARD FABRIC FOR ZERO-WASTE GARMENTS

Klara Kostajnšek, Svjetlana Peulić, Matejka Bizjak
University of Ljubljana / Faculty for Natural Sciences and Engineering, Department of Textiles, Graphic arts and Design / Snežniška 5, 1000 Ljubljana, Slovenia
klara.kostajnsek@ntf.uni-lj.si

ABSTRACT

We live in a time when waste is increasing and becoming a growing problem. Zero-waste is becoming an increasingly important issue in the fashion world, as the fashion industry is one of the top three polluters in the world. The goal of the research was to combine jacquard weaving techniques and zero-waste design. By analyzing the garment cut, we determined the layout of the jacquard pattern and defined the areas with elastane yarns. We produced a garment with minimal waste according to the zero-waste principle of garment production, which considers sustainable principles in addition to the digitalization of the process.

Key Words: zero-waste, jacquard weaving, fabrics, cad system, PBT yarn

INTRODUCTION

There are various sustainability movements to improve the current environmental problem, including the zero-waste movement that contribute to the conservation of natural resources through responsible production [1]. The biggest financial burden for manufacturers is the production processes and textile material. Costs can also be reduced by optimizing the production process, including garment pattern optimization towards toward zero waste [2], with the goal of generating as little textile waste as possible. There are several techniques to reduce textile waste, one of which is to combine weaving techniques with garment pattern development. By using CAD systems that allow rapid design, modification, and simulation of jacquard fabrics, and by developing jacquard patterns in a way that allows the best possible match of the fabric pattern along the seams when it is made into a garment, waste in garment manufacturing can be reduced. By using yarns with elastane-polybutylene terephthalate (PBT) in the weft direction in specific areas corresponding to the garment cut, the fabric was given a 3D shape that conforms to the body after heat treatment [3]. We have managed to design and produced a garment with minimal waste.

EXPERIMENTAL

We started with the design of the pattern and laid it out on the surface in a way that would best suit a jacquard fabric. Using an oriental motif, we arranged the motifs on the surface according to the principle of pattern matching on all diagonals and according to the shape of the of the garment cut (Figure 1, left). In the next step, we simulated the appearance of the jacquard pattern on the shape of the garment. To achieve an aesthetic effect, we placed the smaller pattern for the upper, lighter part and the larger pattern for the lower, darker part (Figure 1, right). Arahne CAD software was used for the fabric design and simulation. The jacquard fabrics were woven on the same warp (CO, 2 x 8 tex; 1 black, 1 white) and three different wefts were combined in the non-elastic area (1 blue PES, 39 tex and 1 white CO, 2 x 8 tex) and elastic area (1 blue PET, 39 tex and 1 white PBT multifilament 2 x 7,8 tex).

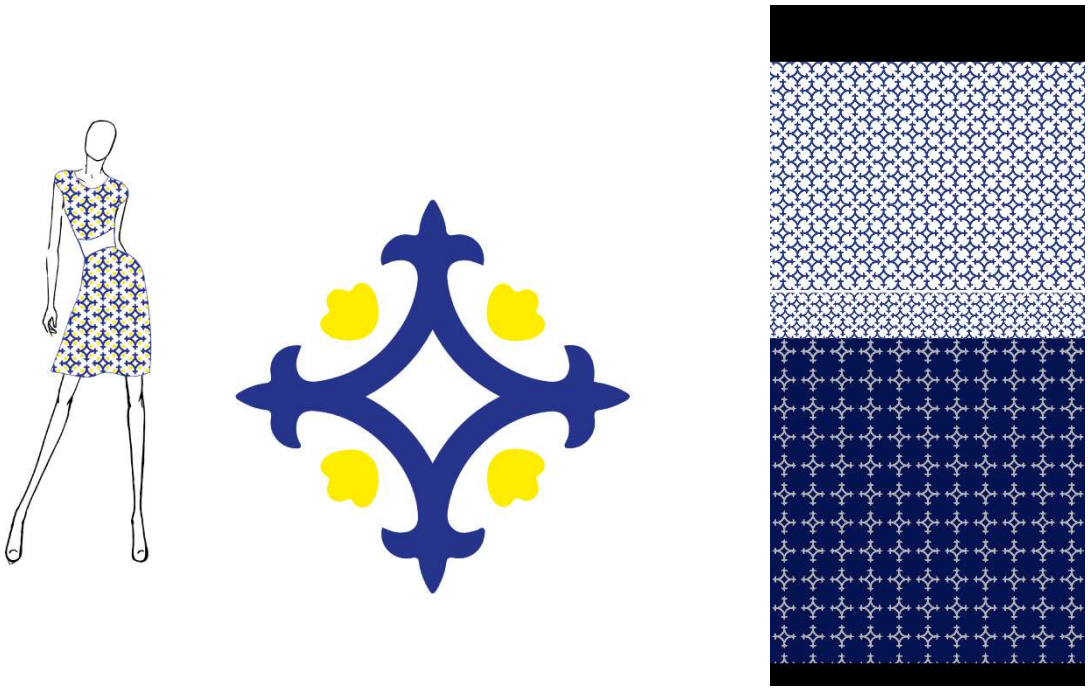
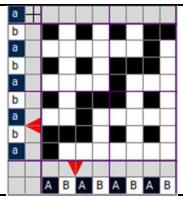
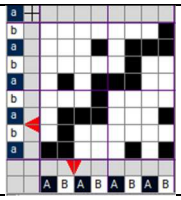
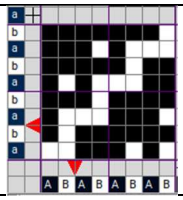
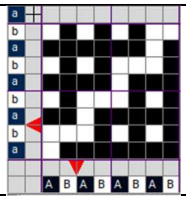


Figure 1. Development of the pattern for the jacquard fabric (left), patterns of the jacquard fabric arranged across the surface according to the garment shape (right)

Two different twill double weaves were used in the jacquard structure (self-stitched for the background and interchanging for the motif), Table 1.

Table 1. Weaves for two colours effect in jacquard patterns

Weaves for the upper part of the fabric		Weaves for the lower part of the fabric	
			
Blue effect	White effect	Blue effect	White effect

Two versions of the fabrics were produced, one with elastic upper part (Figure 2-3) and non-elastic lower part (Figure 2-5), and the second with additional elastic yarns woven over the entire fabric (Figure 2-3 and 4). The fabrics with PBT yarn in the weft were steamed for about 5 minutes to gain the elasticity.

Figure 2. Simulation of fabrics (left), the woven fabric (centre) and the appearance of the fabric with the PBT yarn after heat treatment (right)

RESULTS AND DISCUSSION

By combining different textile techniques, it is possible to design and produce fabrics that comply with the zero-waste principle. We have managed to design and determine the size and distribution of the pattern in such a way as to allow an optimal matching along the seams of the garment, minimizing fabric waste. By using yarns with elastane (PBT) in the weft direction, the fabric was given a 3D shape after heat treatment, which not only supports the shape of the garment, but also adds aesthetic value to the garment. From an economic point of view, we would have chosen a fabric with a partially elastic area that tapers in the upper part of the waist, while remaining flat in the skirt area. However, from an aesthetic point of view, a dress made of a fabric with a continuous elastic area is much better because it fits the body better.

Two dresses were made according to the zero-waste principle, the first from a fabric with an elastic top and a non-elastic bottom (Figure 3, left), the second with a continuous elastic area (Figure 3, right).

Figure 3: Dress made of fabric with elastic upper part and non-elastic lower part (left), dress made of fabric with continuous elastic area (right)

CONCLUSIONS

Modern technologies and digitisation in the field of weaving, weaving preparation and garment production preparation make it possible to quickly and efficiently design garments that are produced according to sustainable principles and with minimal waste. Although designing a jacquard pattern based on the shape of a dress may seem unrealistic in mass production, the digitisation of the processes makes this possible and the process can be used to produce sustainable garments on a small scale. The aim of the research has been achieved; we have produced a garment completely waste free with the appropriate jacquard fabric pattern. Sustainable fashion is a holistic process that encompasses sustainable product design from raw material to manufacturing to recyclability after use.

REFERENCES

[1]RISSANEN, T. Zero-waste fashion design: a study at the intersection of cloth, fashion design and pattern cutting [online], 2023 [cited 22.04.2023]. Available on <https://www.academia.edu/64612126/Zero_waste_fashion_design_a_study_at_the_intersection_of_cloth_fashion_design_and_pattern_cutting>.
[2] MCQUILLAN, H. Hybrid zero waste design practices. Zero waste pattern cutting for composite garment weaving and its implications. The Design Journal, 2019, vol. 22, no. 1, pp 803-819.
[3] KOSTAJNŠEK, K., BAJRIČ, Š., BIZJAK, M. Technological design of jacquard fabric and their functionalization. In Passion for Innovation: AUTEX conference proceedings. Edited by TOKARSKA, N. Lodz: University of Technology Press, June 2022. pp. 55–9.

SUBLIMATION FASTNESS INVESTIGATION OF POLYESTER FABRICS TREATED WITH HYDROPHILIC SILICONE EMULSION

Ayşe Martin[1], **Zeynep Nihan Kır**[1], **Nalan Benli**[1]
[1] *Eksoy Kimya / Ar-Ge Merkezi / Adana*
aysem@eksoy.com

ABSTRACT

After finishing application to the polyester fabrics, there is a decrease in the sublimation fastness of the fabric. Sublimation fastness is classically tested with ISO 105x11 standart. In this study, we developed a new sublimation fastness test metod and compered the results with the sublimation fastness test metod with the ISO 105x11 standard. As a result, the applicability of the test metod has been proven with the results of the 2 test metods being same result.

Keywords: fabric, fastness, sublimation fastness, polyester fabric

INTRODUCTION

The use of polyester fabric is increasing due to its many beneficial properties. It is used in every field from underwear to outerwear due to its slippery and soft structure, low wrinkling rate, and bright and striking colors. It is difficult to dye polyester fabric, contrary to its benefits in its use. No chemical reaction occurs during polyester dyeing because there is no functional group to react in polyester fibers. The crystalline region of the polyester fiber is more than the amorphous region. Polyester fibers are difficult to dye because the dye penetrates the fibers from the amorphous region.
Disperse dyestuffs are used to dye polyester fabric. Disperse dyes have a very high affinity for polyester fiber. In order to dye polyester fibers, the tight fiber structure of polyester fibers must be opened and penetrated through the pores. At high temperatures, the pores of the polyester fibers are opened and the disperse dye penetrates the pores. However, in order for the paint to enter the pores in a balanced way, it is necessary to use a leveling agent. Disperse dyeing starts at 80 °C and gradually increases to 130 °C (1,5-2 m/dk).
Dyeing continues for one hour at 130°C and cooled to 80°C and then reductive cleaning is required. Dead dye on the fabric is removed with reductive cleaning.

In textile industry after dyeing there is a lot of fastness methods like color fastness, light fastness, water fastness, sublimation fastness. Sublimation fastness important for polyesters dye. Because disperse dyes when heated to high temperature, became gasified from solid. The sublimation property idconcerned to the polarity of the substituting group. The polyester and acetate fibres that are dyed by disperse dyes may have fastness problems in the heat setting process or other after-finish processes, which is because of the poor sublimation fastness or dry heat fastness. Polyester fiber or acetate fiber clothing dyed by disperse dyes may have the phenomena of the original shade being changed or stained because of the poor sublimation fastness. (1)
Fort he sublimation test, the ISO 105x11 standard is classically applied. The logic of the test is to place the treated dyed fabric and the untreated fabric together between the heating plate and pollute the untreated fabric as a result of the dye becoming gaseous at a certain temperature and time. Tests are given for hot pressing when the textile is dry, when it is wet, and when it is damp. The end-use of the textile usually determines which test should be made. In this test metod, dye

contamination of the fabric is achieved by temperature. In the sublimated test fastness metod we have developed, we carry out this contamination by means of chemicals, perchloroethylene. Additionally, with this method, sublimation fastness can be conveniently tested without the need for a device.

In this study perchloroethylene used for evaluate to the sublimation fastness. Since perchloroethylene is a very good organic solvent, its success in stain removal and its low toxicity compared to other chlorinated solvents cause perchloroethylene to be widely used in this field. Paint removers and some other stain removers also contain perchloroethylene. (2)

RESEARCH METHOD

Padding Method

The fabric was padded using 1-dip 1 nip in a hydrophilic silicone solution finishing bath with 80–85% wet pickup. Then the padded fabric was dried at 180 °C for 180 s.

Sublimation Fastness Method

Method 1

The sample fabric size is 50x100mm. The size of the accompanying fabric is the same as the sample. It is placed in the sublimation fastness device with the treated fabric at the bottom and the untreated fabric at the top. Kept on the device for 30 seconds at 180 degrees and sample under the pressure of 4kPa. Evaluated the color change according to the grayscale.

Method 2

The treated fabric is cut to 50x50 mm. The fabric is placed on the petri dish. Filter paper is placed on it. A glass plate with a 1 cm hole is placed on it. 0.5 ml of perchlorethylene is dropped through the hole. Hold for 5 minutes. It is then scored.

RESULT AND DISCUSSION

In this study, we compared the iso standard with the sublimation fastness and the newly developed sublimation fastness test method. We evaluated the results according to the gray scale and datacolor color spectrophotometer. We found that the sublimation fastness decreased the results with the increase of silicon content in the finishing agent, while the fabric that was not treated with the finishing agent had the least contamination.

CONCLUSIONS

Examination of sublimation fastness in polyester fabrics is one of the important criteria. This method, which is examined as the dye passing from the gas phase to the solid phase at high temperatures, contaminates the fabric, is examined with the help of a device. In this study, we developed a new method and examined the sublimation fastness with a different method. In this method, we used a chemical that dissolves the dye, perchlorethylene. We tested the accuracy by comparing the results with the classical method.

In our study, we compared fabrics that did not contain a finishing agent and fabrics treated with a finishing agent. It is a known fact that the sublimation fastness of the fabric decreases as a result of the finishing process. Some finishing agents reduce sublimation fastness more, while others give results close to untreated fabric. This actually depends on the silicon content of the finishing material. As the silicon ratio increases, sublimation fastness is expected to decrease. In our study, we used 2 finishing materials with a lower silicon ratio and 2 silicone materials with a higher silicon ratio. When we examined the results, we saw that the finishing materials with high silicon content pollute more.

REFERENCES

[1] https://www.tib.eu/en/search/id/tema:TEMA20060501388/The-sublimation-fastness-of-disperse-dye/
[2] http://www.mikroteknik.com.tr/urunler/perkloretilen/

NEW TECHNOLOGIES TO INTEGRATE PLASTIC WASTE IN THE CIRCULAR ECONOMY

Ozan Onuktav[1], **Bekir Boyaci**[1], **Melike Oya Kader**[1], **Ozan Can Yildiz**[1]
[1]*Sun Tekstil Sanayi ve Ticaret A.Ş. / Yedi Eylül Mahallesi, Celal Umur Caddesi No: 6/A 35860 Torbalı İzmir/TÜRKİYE*
ozan.onuktav@suntekstil.com.tr

ABSTRACT

Over the past few decades, scientists have focused increasingly on combatting the issues plaguing our world's ecosystems. Plastics play a large part in these issues, and recycling has not made a big impact on waste disposal as hoped, mainly being done through incineration and dumping into landfills and water sources. Plastics and textiles are major sources of waste in our lives, but properly recycling them all is challenging, mainly due to the presence of complex fractions in the waste streams.

INTRODUCTION

The PLASTICE project will valorise a variety of unsorted plastic and textile waste by implementing innovative technologies along the whole recycling value chain. The purpose is to close the loop by maintaining the valorisation process performance against feedstock variabilities and by safeguarding the products' quality for their industrial applications. PLASTICE valorisation processes are aligned with the latest chemical recycling roadmaps at EU level, and will be developed and tested at four demo-sites.
The European Consortium composed by 23 partners, including relevant actors such as waste managers, RTO, technology providers and also industrial partners to validate the results.

This robust expertise and multidisciplinary consortium enables more transversal objectives such as the improvement of upstream and downstream processes to maximise the performance of the valorisation routes, and also think on the circularity of the whole plastic life cycle. The EU-funded PLASTICE project tackles the plastic waste challenge with innovative recycling technologies. The project aims to efficiently process diverse plastic and textile waste, ensuring high-quality results across varying complex feed stocks. Digital tools with artificial intelligence will complement PLASTICE technologies to increase their performance.

METHODOLOGIES

Technologies to be tested are: Cascade enzymatic hydrolysis, combined gasification and chemical post-treatment, Hydrothermal liquefaction and Microwave assisted pyrolysis. Each of the technologies will be validated in 4 separated demo sites (2 Spain, 1 Italy and 1 Austria) where some complementary AI and advanced data analysis will be implemented for the optimisation of plastic recycling and sorting processes.

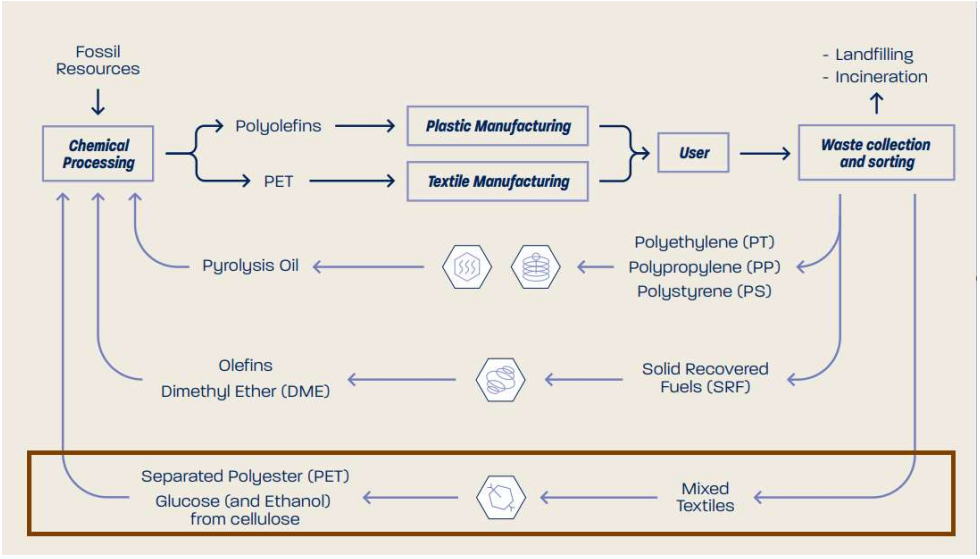


Figure 1. Overall concept and valorisation routes of PLASTICE

OUTCOMES

The Project outcomes to develop and demonstrate new plastic valorisation processes able to treat unsortable streams of mixed plastic and textile waste. To obtain products ready to be fed in downstream processes for the further production of polymers, closing the plastic production loop. To reduce the carbon footprint of current plastics chemical recycling processes between 61 and 82% compared to the current plastic recycling routes. Sun Tekstil is responsible for validation of recycled yarns in new fabric manufacturing for textile industry. Including knitting and finishing processes.

To establish a roadmap for the implementation of PLASTICE solutions in other industrial realities and regions, tackling technical and non-technical (i.e. regulatory and standardisation) barriers. To assure a successful exploitation and dissemination of the project, through a strategic and business-oriented commercialization plan, dedicated business models and key stakeholders' engagement.

PLASTICE is an EU-funded project that aims to propose new technologies to integrate plastic waste in the circular economy. This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No.101058540.

Keywords: chemical recycling, circular economy, textile waste, plastic waste, sustainability

PROTECTIVE CLOTHING: STANDARDIZATION AND CERTIFICATION

Nilgün Özdil
[1] *Ege University / Tekstil Mühendisliği Bölümü, Bornova -İzmir*
nilgun.ozdil@ege.edu.tr

INTRODUCTION

Technical textiles are manufactured and used essentially for their functional properties and technical performance rather than their aesthetic or decorative characteristics [1]. Protective textiles are one of the very important application areas of technical textiles used against a variety of hazards. Protective clothing refers to garments and other fabric-related items designed, fabricated, or treated to protect the wearer from extreme environmental and dangerous working conditions, safeguard the user against possible risks that may result in injuries or death. It is a part of the personal protective equipment (PPE) suite. Protective textiles are classified according to the end-use functions such as chemical- biological protection, mechanical impact protection, thermal (cold) protection, flame protection, radiation protection, wearer visibility and electrical protection. While developing the specialised protective textiles it should be considered that each hazard has its own functional behaviour. Therefore, all protective clothes should be specifically designed and produced to meet the basic requirements against possible risks. In some cases, there may be need to protection against more than one hazard, for example, protection to cutting or chemicals in addition to the protection from fire could be require for firefighter clothing [2-6].

Standards have become the common language of international trade in today's world, where a rapid globalization process is experienced with the development in production technologies. Standardization is the establishment and application of certain rules with the assistance and cooperation of all parties involved, so standardization of specifications or test methods facilitate trade and help to reduce costs. In terms of protective clothing, standardization is a key factor for users' safety [5,7]. Various national and international standardization associations have developed standard test methods and performance specifications since the early 1990s to assess the performance properties of protective clothing. These standard test methods and performance specifications ensure that the performance data on protective clothing are useable, comparable and meaningful [6,8].

STANDARDIZATION AND CERTIFICATION OF PROTECTIVE CLOTHING

In many countries protective textiles fall under the framework of legal regulations. Legal authorities on occupational safety and health in all developed industries accept Personal Protective Equipment (PPE) safety as an essential social factor. Employers have to guarantee a series of requirements to protect the worker. The level of protection of protective garments can be ensured by standards based on advances in the materials used, technical progress in the world, the development of legislation about occupational safety and health, and the consciousness of the user [5].

The product standardization of PPE in Europe is based on the Council directive 89/686/EEC (EC, 1989a) which lays down the basic safety requirements. More than 300 of European standards for PPE have been developed for equipment conformity to the directives. There is a clear difference between the use of PPE products and the manufacture of PPE in Europe. The use of PPE is under

authority of EC directive 89/656/EEC (called `users directive') relevant to the minimum safety and health requirements for using of PPE at the workplace (EC, 1989b). In North America the standardization is mainly implemented by US Department of Labor, Occupational Safety and Health Administration (OSHA). Under a regulation of OSHA, employees must use the proper PPE to avoid workplace hazards and an employer must meet specific requirements about that [5]. Standardization of International PPE over the worldwide is accomplished by ISO (International Standardisation Organisation. Technical Committee (TC) ISO/TC 94 and a series of subcommittees (SC) takes place standardisation of different types of PPE [5,6].

In Turkey, within the scope of Personal Protective Equipment Regulation, there are provisions on Conformity of Personal Protective Equipment, Conformity Evaluation and Use of Personal Protective Equipment. TSE carries out the conformity assessment activities within the scope of the Personal Protective Equipment Regulation. It has been prepared within the framework of harmonization with the European Union legislation [9].

Although standards are very important tools providing a common language about protective clothing, conformity assessment to a standard is required to show minimum level of protection from hazards. This shows the customer that the product meets the requirements and helps with the purchasing decision. Also, provide confidence to the producer about the product [10]. According to the European regulation, the manufacturer has to carry out a `EC declaration of production conformity 'before placing a PPE on the market. It means that the manufacturer writes out a declaration certifying the PPE which is in conformity according to directive 89/686/EEC. EC mark of conformity is affixed on each PPE [5]. PPE products are classified in four categories in terms of on the importance of hazard (simple, medium, complex) they protect against. According to these categories, the required set of tests and certifications (conformity assessment) of a product are different.

CONCLUSION

Protective clothing guards the wearer from environmental and working conditions hazards. The production and certification of protective clothing in according to the standards is very important for the health and safety of the wearer. In this paper a detailed information about the standardization of protective clothes and certification procedures will be given.

Keywords: protective clothing, standardization, certification, Personal Protective Equipment Regulation, conformity

REFERENCES

[1] The Textile Institute, Textile Terms and Definitions, 1991, 9th edn, Textile Institute.
[2] ADANUR, S., Wellington sears handbook of industrial textiles, Lancaster, Pennsylvania, Technomic Publishing Company, Inc.1995.
[3] POTLURI, P. and NEEDHAM, P. Chapter 6: Technical textiles for protection. In Textiles for protection, Edited by SCOTT R. A. England: Woodhead Publishing, 2005, pp 151-175.
[4] ZHOU, W., REDDY, N. and YANG Y., Chapter 1: Overview of protective clothing, In Textiles for protection, Edited by SCOTT R. A. England: Woodhead Publishing, 2005, pp 3-5
[5] HAASE J., Chapter 2: Standards for protective textiles. In Textiles for protection, Edited by SCOTT R. A. England: Woodhead Publishing, 2005, pp 34-48.

[6]DOLEZ P.I., IZQUIERDO V., Chapter 11: Specific testing of protective clothing. In Advanced characterization and testing of textiles, Edited by Dolez P, Vermeersch O, Izquierdo V. England: The Textile Institute Book Series, Woodhead Publishing, 2018, pp 318.
[7] ÖZDIL, N., Tekstilde standardizasyon ve önemi. Tekstil ve Konfeksiyon, 1, 2001, pp: 3-7.
[8] MÄKINEN, H. Protective clothing—nowadays and vision. In 3rd European Conference on Protective Clothing and Nokobetef: book of proceedings, Vol 8. Gdynia, Poland: 10-12 May 2006, pp3.
[9] http://mevzuat.basbakanlik.gov.tr/Yonetmelikler.aspx
[10] COHEN, HJ., LIVERMAN, CT. Certifying Personal Protective Technologies: Improving Worker Safety, Institute of Medicine (US) Committee on the Certification of Personal Protective Technologies,2011 National Academic Press, Avaible on https://nap.nationalacademies.org/catalog/12962/certifying-personal-protective-technologies-improving-worker-safety

BRIDGING CREATIVITY AND TECHNOLOGY: STITCHING IMAGINARY IZMIR FROM ANCIENT TIMES TO AI

Elvan Özkavruk Adanır
Izmir University of Economics/Faculty of Art and Design, Department of Textile and Fashion Design, Sakarya cd. No:156 Balçova-Izmir
elvan.ozkavruk@ieu.edu.tr

The idea of creating systems that "think like humans" first emerged in the 1950s, and John McCarthy conceptualized this idea as "artificial intelligence" in 1956. Artificial intelligence studies have come to a halt from time to time due to economic conditions and high expectations [1]. Nevertheless, at present AI applications continue to develop at full speed and AI applications are used in many sectors such as technology and computer, health and medicine, finance and banking, retail and e-commerce, transportation and automotive, textile and fashion, as well as in the field of art and culture.

Throughout 2022, a remarkable surge in AI-powered tools such as MidJourney, Stable Diffusion, DALL·E, and ChatGPT has captured widespread attention. These models manifest the capability to generate distinct images or textual content through a synthesis of human- supplied text prompts, specified parameters, or imagery. In the wake of DALL·E and MidJourney gaining considerable traction within the mainstream, a fervent discourse has ensued at the confluence of artistic and technological domains. This discourse primarily orbits the adverse ramifications of AI-generated imagery upon the professional cadre of artists. Notably, this deliberation exhibits a pronounced polarization, characterized by vociferous assertions from disparate factions, often marked by a lack of constructive dialogue and meaningful engagement [2].

Indeed, considering the humanistic dimension of art, distinct from the conventional advancement of human intelligence within the realms of science and technology, the emergence of AI constitutes a paradigm shift, offering novel dimensions to the domain of art. Central to this discourse is an exploration of how AI engenders shifts and alterations in our perceptual understanding of art, thereby illuminating a vital area for scholarly deliberation and contemplation [3].

In this paper, it is intended to discuss the potential impact of AI in creating art. The visuals of the textile artwork titled "Imaginary Izmir: From Ancient Times to Artificial Intelligence" were created with the collaboration of MidJourney. The artwork aims to reflect the history and cultural values of Izmir by blending the traditional with the modern. The historical and cultural heritage of Izmir is reinterpreted through an imaginary perspective. Using artificial intelligence, images of Izmir from different periods have been created and transferred onto fabric through digital printing. Each period is represented by three unique works (Figure 1-2), and these pieces are given dimensions through the traditional quilting technique. Each artwork combines the texture of the past with a modern approach, showcasing the harmony of art and technology. Imaginary Izmir endeavors to present a synthesis of the past's essence with the technology of the future.

Figure1: "Imaginary Izmir From Ancient Times to Artificial Intelligence" Series, Ancient Times

Figure 2: "Imaginary Izmir From Ancient Times to Artificial Intelligence" Series, 21[st] Century Izmir: Suburbs and the City

Keywords: Artificial Intelligence, AI Art, MidJourney, Textile Art

REFERENCES

[1] UNAL, E. Yapay Zekadan Sanatçıya. Tübitak Bilim ve Teknik Dergisi, Aralık, 2018, pp 58-66.

[2] DENNIS, S. The AI Art Debate: Excitement, Fear and Ethics, Towards Data Science[online], updated 22.12.2022 [cited 21.08.2023]. Available on https://towardsdatascience.com/the-ai-art-debate-excitement-fear-and-ethics-c04d30f338da

[3] ASLAN, E. Yapay Zekâ Resimleri ve Sanatın Başkalaşan Mecrası Üzerine, Güzel Sanatlar Enstitüsü Dergisi , 2019, 42, pp 231-242

MULTI-PURPOSE KNITTED BABY WRAP

Alenka Pavko Čuden[1], **Lenka Petrović**[1], **Andrej Vilar**[1]
[1] *University of Ljubljana / Faculty of Natural Sciences and Engineerng, Department of textiles, Grašhic Arts and design / Aškerčeva 12, 1000 Ljubljana, Slovenia*
alenka.cuden@ntf.uni-lj.si

Baby and child carriers are support devices used by adults to carry children in close contact with their bodies. They help carry or hold the child for long periods of time during walks, outings, errands, etc. Adults can carry the baby in contact with their abdomen and chest, at the hip, or on their back. The babies can face the adults to interact with them, or they can face away from them to observe their surroundings while being carried close to the chest or at the hip. Baby carriers are made from a variety of raw materials and fabrics that vary in stiffness to provide adequate support. Modern textile baby carriers are ergonomic and support the child's natural posture, promote physical development, are safe, allow freedom of movement, and are comfortable [1].

There is a lot of information, reviews and advice about baby/child carriers on the websites of manufacturers and sellers of these products, as well as on parenting blogs. Many scientific studies have also been conducted, e.g. from the area of measuring loads during baby carrying [2, 3, 4], on the physiological response of wearers in terms of muscle load, etc., during the use of different carriers [5, 6], on the impact of carrying newborns in baby carriers on the duration of breastfeeding [7], etc. All this proves that baby carriers are a marketable product that requires comprehensive planning.

For over a decade, baby carriers have (re)enjoyed popularity; they are especially useful for carrying babies and children when the stroller is too rigid and in the way. Baby carriers increase the comfort of the wearer when carrying children and free up the hands, but at the same time must provide the baby/child with adequate position and support for the head and spine. The child must not be shrink-wrapped in the carrier, as such a position may impede his/her breathing. When using carriers, the baby's/child's age and stage of development must be considered; experts do not recommend the use of carriers until the child is 3 months old. Parents who choose and use an unsuitable baby carrier that is not adapted to the age and developmental stage of the child unintentionally influence its development and risk spinal damage [8].

Carrying children is strenuous work that consumes a lot of energy. The weight of a child increases rapidly with growth: from about 3 kg at birth to about 10 kg at the age of one year. Energy consumption when carrying a baby in a carrier is lower than when carrying a baby in the arms, but higher than when carrying a baby on the back [2]. Babywearing has many advantages at the same time:

- allows freedom of movement for the wearer,
- calms the child as he/she feels the touch, rhythm and heartbeat,
- facilitates communication and helps to identify the child's needs,
- allows the father to participate more actively in the care and upbringing of the child,
- facilitates play and care for siblings
- helps in the occurrence of colic [9].

Children in baby carriers can suck and bite, drool and sweat on the material, so they must be made of materials that do not contain harmful substances [8].

We know different types of baby carriers: wraps, soft structured carriers, ring slings, pouch slings, and Asian style baby carriers.

Knitted baby wraps are simple in shape and suitable for waste-free production on a flat knitting machine. In the research work, we investigated baby wraps and their possible multifunctionality. In the theoretical part, we studied baby carriers over time and in different

cultures, as well as traditional concepts in the development of children's clothing and equipment. In the experimental part, we designed a multipurpose baby wrap made of single jacquard knit and interior textiles for the nursery. We tested the functional properties of the fabric from which the baby wrap was made.
We found that fully-fashion flat knitting using eco-cotton is a suitable technology to produce sustainable knitted multipurpose baby wraps without waste. The research results also showed that the combination of plain and mesh single weft knitted fabric ensures suitable performance characteristics for making a knitted baby wrap. Knitted baby carrier wraps can be designed and manufactured as multipurpose products. By folding and sewing, they can be transformed into a product with a different functionality. This versatility increases their sustainability value. Moreover, mass-produced knitted baby wraps can be customised using creative DIY textile techniques.

Keywords: knitting, knitted fabric, baby carrier, wrap, ring sling.

[1] Baby Carrier Market: Global Industry Trends, share, size, growth, opportunity and forecast 2022-2027 (2022) Global Information, Inc. (GII) - Premium market research reports. Available at: https://www.giiresearch.com/report/imarc1077777-baby-carrier-market-global-industry-trends-share.html (Accessed: 24 May 2023).
[2] INUKAI, H.I. (1998) Physical Load of Carrying Baby in Arms or in Baby-Carrier, Journal of Home Economics of Japan, 49(11), pp. 1233–1239. doi:https://doi.org/10.11428/jhej1987.49.1233.
[3] WALL-SCHEFFLER, C.M., GEIGER, K. AND STEUDEL-NUMBERS, K.L. (2007) Infant carrying: The role of increased locomotory costs in early tool development, American Journal of Physical Anthropology, 133(2), pp. 841–846. doi:10.1002/ajpa.20603.
[4] WILLIAMS, L., STANDIFIRD, T. AND MADSEN, M. (2019) Effects of infant transportation on lower extremity joint moments: Baby Carrier versus carrying in-arms, Gait & Posture, 70, pp. 168–174. doi:10.1016/j.gaitpost.2019.02.004.
[5] WU, C.Y., HUANG, H.R. AND WANG, M.J. (2016) Baby carriers: A comparison of traditional sling and front-worn, rear-facing harness carriers, Ergonomics, 60(1), pp. 111–117. doi:10.1080/00140139.2016.1168871.
[6] LEE, H. AND HONG, K.H. (2018) Type and wearing method-dependent cop and muscle fatigue measurement of baby carriers for the development of Smart Baby Carriers, International Journal of Clothing Science and Technology, 30(5), pp. 610–627. doi:10.1108/ijcst-11-2017-0178.
[7] PISACANE, A. et al. (2012) Use of baby carriers to increase breastfeeding duration among term infants: The effects of an educational intervention in Italy, Acta Paediatrica, 101(10). doi:10.1111/j.1651-2227.2012.02758.x.
[8] BEVC BAHAR, J. (no date) Otrok in Družina, ZPS - Zveza potrošnikov Slovenije. Available at: https://www.zps.si/otrok-topmenu-258/oprema-in-tekstil-topmenu-260/10454-zdrav-razvoj-otroka-naj-bo-pred-udobjem-starsev (Accessed: 25 May 2023).
[9] Nosilke in vse o nošenju: MojŠkratek, trgovina z nosilkami (2019) MojŠkratek. Available at: https://mojskratek.si/nosilke (Accessed: 25 May 2023).

FASHION, TECHNOLOGY AND SUSTAINABILITY IN CONTEMPORARY KNITTING

Alenka Pavko Čuden
University of Ljubljana / Faculty of Natural Sciences and Engineering, Department of Textiles, Graphic Arts and design / Aškerčeva 12, 1000 Ljubljana, Slovenia
alenka.cuden@ntf.uni-lj.si

Both fashion and technology are described as interdisciplinary processes that combine different disciplines and tools to create user experiences. Throughout history, they have found points of contact and strongly influenced each other. Fashion, design, natural sciences, engineering, and economics and management combine in a field also known as "fashion-tech," defined as "the ways in which innovative technology plays a role in the fashion industry, shaping everything from design to manufacturing to retail and more." As the fashion world embraces technological advancements, the industry has changed on both the production and consumption sides [1]. Fashion-tech products and/or services can be developed for their functionality, to create communication opportunities, and for greater sustainability [1], as well as to improve the way we produce and consume fashion [2]. Fashion-tech designers are designing wearables that give new functions to the human body and interact with the environment. Tools such as 3D printing, artificial intelligence, augmented reality, and digital fabrication are among the recent technological advances that enable the design of these smart textiles [3]. Major knitting machine manufacturers have also joined the fashion tech stream, showcasing the capabilities of their machines at textile machinery trade shows such as ITMA, as well as fashion yarn trade shows such as Pitti Filati, technical textiles trade shows such as Techtextil, and functional textiles trade shows such as ISPO sports trade show.

Eco-tech fashion was first introduced by Sarah Scaturro in a 2008 article titled "Eco-Tech Fashion: Rationalizing Technology in Sustainable Fashion" in the journal Fashion Theory. The term "eco-tech" originated in the field of architecture and refers to the belief that technology is a necessary component of a truly sustainable system [4]. Nowadays, attention to issues such as sustainability, environmental protection and health is growing both in public opinion and among policy makers. In this context, the textile and clothing industry as a whole, as well as individual sectors such as the knitting industry, are considering adopting sustainable development as a business model that pays more attention to environmental issues and human well-being. However, the path to sustainability as a means of promoting growth requires both technological and cultural innovation [5].

Textile and clothing trade shows such as Techtextil, ITMA and ISPO have shown that more and more companies are adopting approaches to greater sustainability based on the "cradle-to-cradle" concept. In knitting, the main focus is on using recycled, reused or even waste materials and increasing production efficiency. Shortening the manufacturing process of a knitted product can be achieved in three ways: by increasing production speed/efficiency, by introducing new technology that allows certain process steps to be skipped, such as seamless knitting, or by merging two or more processes into one, such as hybrid spinning- knitting and sock toe-closing directly on the knitting machine.

In the last decade of the 20th century, knitting seamless clothing accessories evolved into knitting seamless garments. The manufacture of pantyhose led to the development of body-size seamless circular knitting machines, while the manufacture of gloves inspired the development of the so-called »Wholegarment« and »Knit&Wear« flat knitting machines. This was followed by the development of seamless warp knitting machines. All this led to a commercially successful, low-waste or even waste-free seamless knitting industry of the 21st century. Yet

there seems to be a dilemma as to whether seamless knitting is really as sustainable as it is made out to be.

Knitting is a constantly evolving process technology that, when combined with digital modeling and design, offers remarkable potential for unlocking opportunities by connecting to the Internet. Knitted fabric manufacturers are increasingly using IoT technology in the manufacturing process to improve production efficiency. Knitting machines equipped with IoT sensors are connected to the Internet, enabling real-time monitoring of production equipment. IoT technology is also used for predictive maintenance of machinery in fabric manufacturing facilities. The data collected from knitting machines in real time helps optimize production planning.

Although the development of sustainable knitting materials and knitting equipment is enabling a slow but steady transition to a sustainable society, the current growth and expectations for further growth of the knitted fabrics and knitwear market indicate that consumerism is still strongly entrenched and awareness of the importance of rational production and consumption in knitting is still far off.

Keywords: knitting, fashion, technology, sustainability, internet of things

[1] Team YouCam (2022) AI fashion technology - the complete guide 2023, PERFECT. Available at: https://www.perfectcorp.com/business/blog/general/the-complete-guide-to-fashion-tech (Accessed: 25 May 2023).
[2] KNOX, B. (2021) What is Fashion Technology in 2022 - expert definition & examples, The VOU. Available at: https://thevou.com/fashion/what-is-fashion-technology/ (Accessed: 25 May 2023).
[3] SHAKERI, S. (2022) 10 fashion-tech designers revolutionizing the fashion industry -, Parametric Architecture. Available at: https://parametric-architecture.com/10-fashion-tech-designers-revolutionizing-the-fashion-industry/ (Accessed: 8 June 2022).
[4] SCATURRO, S. (2008) Eco-tech fashion: Rationalizing technology in sustainable fashion, Fashion Theory, 12(4), pp. 469–488. doi:10.2752/175174108x346940.
[5] The ACIMIT Green Guide 2015 (2015). Normanton, West Yorkshire: MCL Global, pp. 4-6.

DEVELOPMENT OF OZONE EFFECTING SYSTEM WITHOUT USING HARMFUL CHEMICALS

Emre Sakan[1], **İrem Palabiyik**[2]
[1, 2] *FG Tekstil Konfeksiyon San. Tic. A.Ş./R&D Center, ITOB Organized Industrial Zone Neighborhood, 10032 Street, No.9, İzmir, Turkey.*
emre.sakan@wiserwash.com.tr

ABSTRACT
New eco-friendly and sustainable denim bleaching methods have been developed as an alternative to traditional chemical-based processes. These methods utilize ozone technology to achieve textile washing and desired effects without the use of harmful chemicals. The results have shown successful outcomes in terms of both technical and visual aspects when compared to traditional bleaching methods. The new method has reduced processing time and water consumption by approximately 53%. Additionally, it has decreased energy and water consumption, minimized the use of harmful chemicals, and reduced the negative impact on the environment and human health.

INTRODUCTION
Denim fabric, traditionally associated with jeans, has evolved into a versatile material used in various clothing types. Previously, denim products were sold without washing, resulting in a stiff texture that developed effects and coloration over time [1]. Denim washing processes, categorized as physical and chemical washing, aim to enhance properties, and create desired effects. Among these processes, denim bleaching using chemicals like potassium permanganate and sodium hypochlorite is effective in achieving a lighter and more effective apperance to the clothing. However, ozone bleaching has emerged as a sustainable alternative, degrading indigo molecules without harmful chemicals. Ozone bleaching reduces water and energy consumption, shortens production time, and allows for wastewater reuse. This study highlights the benefits of ozone bleaching in improving denim properties compared to traditional methods.

MATERIALS AND METHODS
The Reaction of the Formation of Ozone
Ozone is formed in the atmosphere when ultraviolet (UV) radiation dissociates molecules of oxygen, O2, into separate oxygen atoms. These atoms can then combine with other oxygen molecules to form ozone. Conversely, ozone can be broken down into atoms and oxygen molecules by UV radiation [2]. Formation and disintegration of ozone are showed below in Figure 1.

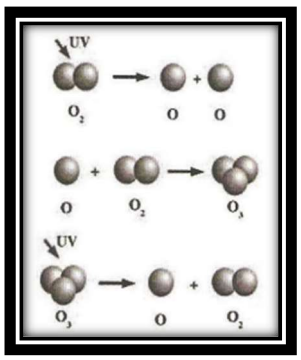


Figure 1. The Scheme of Formation of Ozone (Öztürk & Eren, 2010).

The Use of The Ozone Device and The Reaction of Ozone with The Indigo Molecule

The ozone generator is set up to treat the fabric, followed by placing the fabric in the washing machine. When ozone gas reacts with oxygen radicals in the indigo dye, it results in a lighter and effective version of the original color [3]. Indigo carmine molecule disintegration of ozone are showed below in Figure 2.

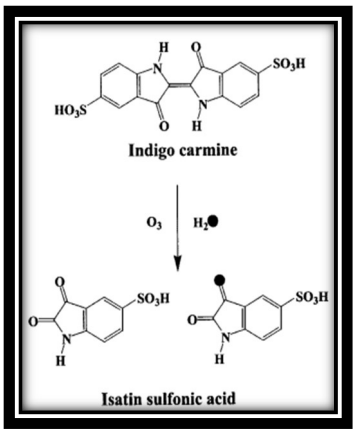


Figure 2. Indigo carmine molecule disintegration of ozone (Kettle et al., 2004).

RESULTS AND DISCUSSSION

In this study, traditional wash and Wiser Wash systems are compared is showed in table 1. Comparison is made by only one denim garment product between traditional wash and wiser wash.

TRADITIONAL WASH		WISER WASH
350 g	SODIUM HYPOCHORITE	No
1.4 g	POTASSIUM PERMANGANATE	No
492,42 g	AVG CHEMICALS	12.50 g (ZDHC Approved)
60 L	WATER	28 L
2 kg	PUMICE STONE	No
1.11 kW	ELECTRICITY	0.8 kW
355 min.	PROCESS	198 min.

Table 1. The comparison of traditional wash and Wiser Wash (ozone) technology

Table 1 shows a comparison between the traditional method and Wiser Wash. The traditional method uses sodium hypochlorite, potassium permanganate, and pumice stone, whereas Wiser Wash eliminates the use of these chemicals. The use of harmful bleaching chemicals and AVG Chemicals has been eliminated or reduced significantly in Wiser Wash. Energy consumption is also reduced, with traditional washing using 1.11 kW of electricity compared to Wiser Wash's 0.8 kW. Processing time is shorter in Wiser Wash, taking 198 minutes compared to the traditional method's 355 minutes. The highest consumption in denim washing plants is water consumption. and Wiser Wash reduces it from 60 liters to 28 liters. Overall, Wiser Wash offers significant savings in terms of chemicals, energy, and water consumption.

Two water samples were taken from denim washing baths of the traditional and Wiser Wash methods. The spectrophotometric method was employed to determine the quantity of potassium permanganate in the baths. The spectrophotometer device passed light through the solution (bath sample) at specific spectra and measured the amount of light absorbed by the solution. A higher concentration of potassium permanganate in the bath sample led to increased absorption of light. By quantifying the intensity of light that could pass through the water sample, the

spectrophotometer provided information about the potassium permanganate content in the bath sample. The test results using the spectrophotometric method revealed a significantly lower amount of potassium permanganate in the Wiser Wash method compared to the traditional method. However there is no use of Potassium Permanganate in the Wiser Wash method. The test results are showed in table 1. and table 2.

PARAMETER	UNIT	RESULT
$KMnO_4$	mg/lt	0,1
$KMnO_4$	mg/lt	0,3
$KMnO_4$	mg/lt	0,2

Table 2. Amount of Potassium Permanganate in Ozone Technology

PARAMETER	UNIT	RESULT
$KMnO_4$	mg/lt	159,4
$KMnO_4$	mg/lt	175,91
$KMnO_4$	mg/lt	210,37

Table 3. Amount of Potassium Permanganate in Traditional Technology

CONCLUSION

Wiser Wash technology has proven to be successful both technically and visually when compared to the traditional wash method. In terms of denim fabrics per unit product, Wiser Wash has shown a 53% reduction in water consumption, 27% reduction in energy consumption, and 41% reduction in process time. The number of baths has decreased from 15 to 7, and the processing steps have decreased from 32 to 11. The use of ozone gas in innovative denim bleaching processes has gained attention due to its environmentally friendly and cost-effective nature. Overall, ozone bleaching technology has reduced the harmful effects of traditional denim washing processes on the environment and human health.

Keywords: Denim Bleaching, Ozone, Giving Effect, Traditional washing, Wiser washing.

REFERENCES

[1] Özdemir, D., (2006). Denim Mamullerin Ağartılmasında Kullanılan Sodyumhipoklorit ve Potasyum Permanganat Yöntemlerine Alternatif Yöntemlerin Araştırılması, Yüksek Lisans Tezi, Ege Üniversitesi 1,2s.

[2] Öztürk, D & Eren, H. A., (2010). Tekstil terbiyesinde ozon kullanımı, *Uludağ Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi,* 15(2), 37s

[3] Kettle, A. J., Clark, B. M. & Winterbourn, C. C., (2004). Superoxide converts indigo carmine to isatin sulfonic asid, *The Journal of Biological Chemistry,* 279(18):18522p.

ECO-FRIENDLY, SUSTAINABLE APPROACH TO DENIM WASHING PROCESS

Semanur Şen Yuvayapan[1], **Pınar Durgut**[1], **Emre Kalaycıoğlu**[1]
[1] Ak-Kim Kimya San. ve Tic. A.Ş, Merkez Mah.Akkim sok. No:7,Taşköprü,Çiftlikköy, Yalova, 77602, Türkiye
semanur.senyuvayapan@akkim.com.tr

Denim, a cotton woven fabric, may be the most considered article of style today. It is an icon and one of the most familiar products within the textile industry that attracts all age groups. Today design is deficient without denim.[1] The most well-known denim is indigo denim, in which the twist string is coloured whereas the weft string is left white

The use of denim items in the world has expanded in past years. The global denim jeans market size was valued at $56,204.8 million in 2020 and is estimated to reach $88,138.0 million by 2030, registering a CAGR of 4.2% from 2021 to 2030. [2]

The resources consumed by such a large industry throughout the process is high. Although denim and jeans have a prominent role in the fashion trade, it is time to think about jeans' impact on the environment. The American Chemical Society mentioned that the production of a pair of jeans consumes more than 10000 L of water (including cotton growing, dyeing and processing of denim), about a half kg of chemicals (in the form of dyes, auxiliaries and finishing agents) and a vast amount of energy (including the irrigation of cotton and subsequent processes such as spinning, weaving etc.).[3]

In this study we wanted to focus on one of the significant process of denim producing: Denim Washing. Denim washing stands out as a part of the essential production processes needed to meet the rapidly rising and changing fashion market's demands. Denim washing is an aesthetic finish that is imparted to fabric to improve the softness and comfort of the fabric. In addition, the fabric achieves a different look such as a faded or worn-out appearance.

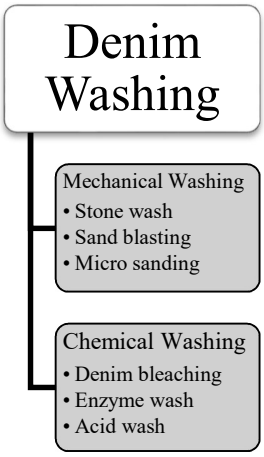


Figure 1: Denim Washing Techniques

Sandblasting, Microsanding are like a mechanical finish which uses sand containing silica. The minute silica dust spreads in air and poses serious respiratory disease such as silicosis.
Chemical washing such as bleaching employs chemicals such as sodium hypochlorite or potassium permanganate. It is harmful to human health and corrodes the stainless-steel drum of the bleaching machine. The effluent contains chlorinated organic substances which cause severe pollution to the environment.
Dry treatments or nearly water-free treatments are slowly becoming a sustainable trend for replacing traditional wet treatments in denim washing, such as laser and ozone treatment. Laser treatment is a water-free, colour fading treatment of denim and is an ecological and economical process. Lasers can create local abrasion, fabric breaks and a 'used' look effect with excellent reproducibility and higher productivity. [4]
In ozone treatment, the ozone generated in the equipment can provide a bleaching effect. Commercially available ozone equipment is operated like a washing machine but without much use of water for the colour fading process. In coming years, denim washings may involve only such dry or water-free treatments. We are trying to support such a clean applications' performances with our eco-friendly products. In this study, we improved ozone and laser treatments' performances with chemicals' special penetration properties. For an advance appearance with more sustainable way, products behave like an activators. Desired results can obtain with less application time. In addition to that; when we compare the ozone processing (which boost with a chemical) with conventional method; the consumptions of water, energy and chemical are much lower. Water consumption is reduced by 50-55%, energy consumption by 45-50%, chemical consumption by 80-84%. With the development of like these products and technologies, the number of studies that will focus on more ecofriendly sustainable textile production will increase.

Keywords: Ozone, denim, oxidation, auxiliary chemical

[1] PAUL R. Denim and jeans: an overview. Denim: manufacture, finishing and applications. 2015.p 1.
[2] Denim Jeans Market Size, Share & Trends Analysis Report By Distribution Channel (Online, Offline), By End-user (Men, Women, Children), By Region (North America, APAC, Europe, Central & South America, MEA), And Segment Forecasts, 2022 – 2030
CAGR: Compound Annual Growth Rate
[3] HMIDA Sarra Ben, and LADHAR Neji., Ozone: Scıence & Engıneerıng 2015, p, 15.
[4] KORLU Aysegul E., The Journal of the International Ozone Association, 2006, p, 24.

AN INVESTIGATION OF ELECTROMAGNETIC SHIELDING EFFECTIVENESS PROPERTIES OF POROUS STRUCTURE IN NON-WOVEN FABRICS

Sinem Tiryaki Güzel[1], **Erhan Sancak**[2], **Mustafa Sabri Özen**[2]
[1] *Marmara University, Institute of Pure and Applied Sciences, Textile Engineering, Istanbul, TURKEY.*
[2] *Marmara University, Technology Faculty, Department of Textile Engineering, Istanbul, TURKEY.*
sinemtiryaki@live.com

ABCTRACT

In the study, electromagnetic shielding efficiency (EMSE) absorption and reflectivity properties of fabric produced from staple stainless-steel fibers and recycled staple polyester fibers by carding and needling technologies were investigated. As the conductive fibres were very expensive, the aim of the study was to obtain optimum shielding effectiveness with usage of minimum conductive fibres. The fibre webs were formed at wool type carding machine and then the folded webs were bonded mechanically with needle punching machines. As shown in the figure below, fabric structures with 4 different pore sizes of the conductive structure were produced. It was aimed to investigate the effect of the pore size formed by the conductive structures on the electromagnetic shielding efficiency. Electromagnetic shielding properties, absorption and reflection characteristics of needle punched nonwoven fabrics were performed by coaxial transmission line method according to ASTM-D4935-10 in the frequency range of 15MHz to 3000MHz. It is a known fact that electromagnetic shielding effectiveness increases with the increase of the pore size and the amount of conductive fibre. The developed EMSE nonwoven fabrics have potential applications in defence applications such as military tent, military secret room, protective cover, missile cover and building as an EMI shielding material.

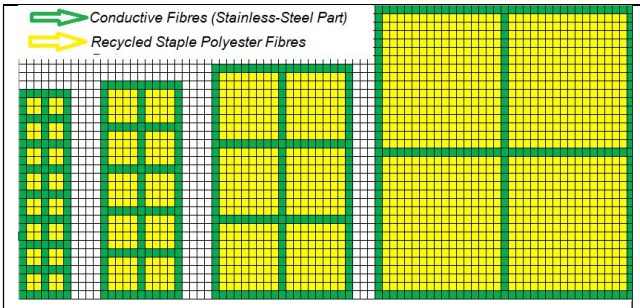


Figure 1. The appearance of the porous structure in non-woven fabrics

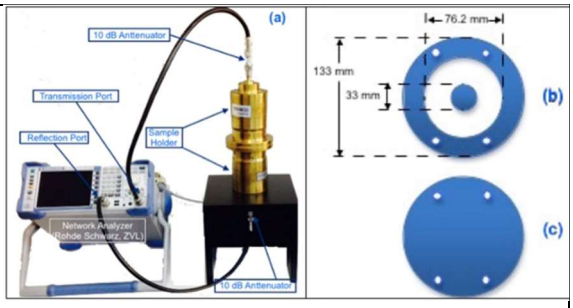


Figure 2. (a) Set up of the Electromagnetic Shielding Effectiveness testing apparatus; (b) and (c) Specimen for reference and load respectively.

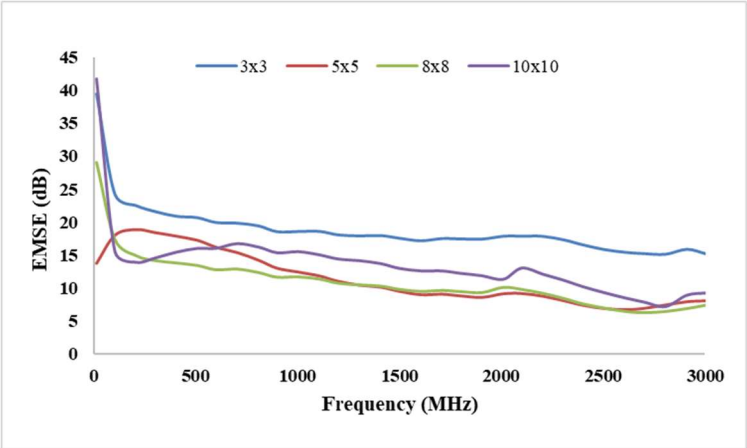


Figure 3. Electromagnetic Shielding Effectiveness Properties of Nonwoven Fabrics

Keywords: Electromagnetic shielding (EM) effectiveness, Electromagnetic radiation, Stainless steel fibre, Recycled polyester fibre, Needle punching, Nonwoven fabric

REFERENCES

[1] BRZEZINSKI, S., RYBICKI, T., MALINOWSKA, G., KARBOWNIK, I., RYBICKI, E., SZUGAJEW, L. (2009) Effectiveness of Shielding Electromagnetic Radiation, and Assumptions for Designing the Multi-layer Structures of Textile Shielding Materials. Fiber & Textiles in Eastern Europe, 17(1), 60-65.

[2] BRZEZINSKI, S., RYBICKI, T., KARBOWNIK, I., MALINOWSKA, G., RYBICKI, E., SZUGAJEW, L., LAO, M., SLEDZINSKA, K. (2009) Textile Multi-layer Systems for Protection against Electromagnetic Radiation. Fiber & Textiles in Eastern Europe, 17(2), 66-71.

[3] PALAMUTÇU, S., ÖZBEK, A., KARPUZ, C., DAĞ, N., ÖZTÜRK, P. Elektromanyetik Kalkanlama Özelliği Olan Tekstil Yüzeylerinin Üretimi ve Yüzeylerin Kalkanlama Etkinlik Alanının Araştırılması.Tübitak Projesi, 107M454, 2010. (092)

[4] PARK, K. Y., LEE, S. E., KIM, C. G., HAN, J. H. (2006) Fabrication and Electromagnetic Characteristics of Electromagnetic Wave Absorbing Sandwich Structures. Composites Science Technology, 66, 576-584.

[5] ÖZEN M.S., SANCAK E., BEYIT A., USTA İ., AKALIN M. (2013) Investigation of Electromagnetic Shielding Properties of Needle-Punched Nonwoven Fabrics With Stainless Steel and Polyester Fiber. Textile Research Journal, 83(8), 849-858.

[6] ÖZEN M.S., SANCAK E. (2016) Investigation of Electromagnetic Shielding Effectiveness of Needle-Punched Nonwoven Fabrics with Staple Polypropylene and Carbon Fibres. The Journal of The Textile Institute, 107(2), 249-257.

[7] HUA Z., PING C., RUIXIN W., HUI Z. (2007) Microwave Absorption Properties of Carbon Fiber Containing Nonwovens. Indian Journal of Fibre &Textile Research, 32, 391-398.

[8] ÖZEN M.S., SANCAK E., AKALIN M. (2015) The Effect of Needle-Punched Nonwoven Fabric Thickness on Electromagnetic Shielding Effectiveness. Textile Research Journal, 85(8), 804-815.

[9] ÖZEN M.S., SANCAK E., SOIN N., SHAH T.H., SIORES E. (2016) Investigation of Electromagnetic Shielding Effectiveness of Needle Punched Nonwoven Fabric Produced from Conductive Silver Coated Staple Polyamide Fibre. The Journal of The Textile Institute, 107(7), 912-922.

DENIM ART

Selda Yıldız,
[1]*Çukurova University,Adana*
[2] *Bossa Dnim Company,Adana*
sld.sbnc@hotmail.com

Reducing the harm of chemicals to the environment and efficient use of natural resources
Various researches and studies have been carried out to reduce the water used in conventional warp dyeing processes. For this purpose, a machine design that will make a difference in denim warp dyeing has been made. Except for dye groups such as indigo, sulphur, reactive and indanthrene used in warp dyeing, dyeing is planned with pigment dyestuffs that had not been used in warp dyeing before.
It is not possible to complete the dyeing process without using water in standard warp dyeing processes. After dyeing, water contaminated with chemicals accumulates as waste. In order to perform warp dyeing without using water with the newly proposed dyeing process, modification processes have been carried out in the existing processes.

Rope dyeing and slasher (open width) dyeing processes are conventionally applied in warp dyeing in denim fabric production. The newly developed process, one of the existing machines that is not a warp dyeing machine, was modified to become a warp dyeing machine.

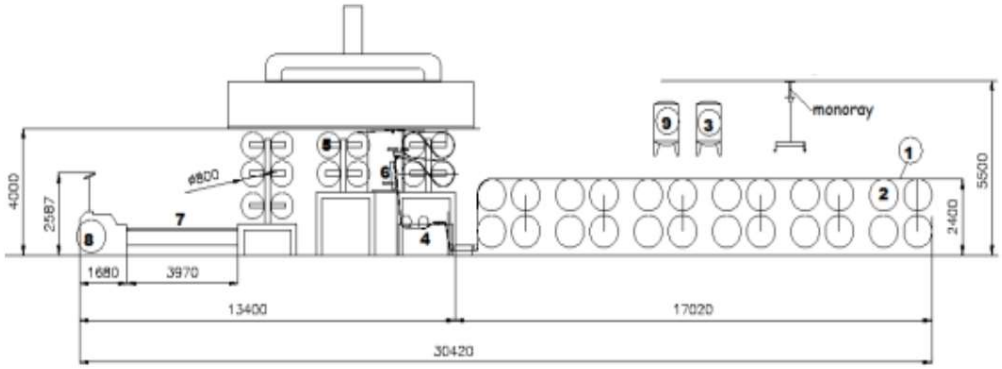


Figure 1. Modıfied machine

Different colours have been added to the denim world by dyeing with the dye group that is not used in warp dyeing in the denim industry.
Behaviours of the determined dye group in double-triple combinations and reproducibility studies were carried out.
In order to increase the binding of the determined dye group on the warp, a binder research based on high temperature was carried out, and one of the important steps of dyeing was carried out with the resulting gots approved binder.

Studies were carried out on different blend yarns and constructions. These studies were supported by different finishing processes (Mercerise, Bleach, Overdye Dyeing, Coating, Brush, Raising etc.) and colour and effect evaluations were made.
Different finishing works were carried out in order to obtain the desired effect of the dyestuff group used.

The test results of the product and garment washing behaviours were evaluated. After Garment washing, user tests were carried out and the effects on the end user were examined. To observe and improve repeatability, long mt productions were planned and dyed.

Contrary to conventional dyeing with warp indigo, sulphur and reactive dyes, this newly developed warp dyeing system added new, vibrant colors to the denim world. The finishing of the fabric was also possible with less water and process. Fabric production was carried out with a more environmentally friendly approach.

Keywords: colour denim,ecological dyeing

LOW TEMPERATURE BLEACHING OF COTTON FIBER BY NOVEL CATALYST

Canberk Yüksel[1], **Semanur Şen Yuvayapan**[1], **Emre Kalaycioğlu**[1]
Ak-Kim Kimya, Taşköprü,Çiftlikköy, Yalova, 77602, TURKEY
deniz.tuncbeyazit@akkim.com.tr

Cotton has been grown for fiber, food and even fuel for over 6.000 years. The cotton is one of the most important fiber and play important role in textile industry. It is a natural fiber and spun into a soft yarn. The cotton fabrics are favoured among natural cellulose fabrics because of their comfort, breathability, and softness[1].

The cotton that has been harvested from the plants will have seeds embedded inside it, pectin, ash, organic acid, wax, sugars and others which need to be mechanically and chemically cleaned before further processes. From field to fabric, the process of making cotton transforms the raw fibers into threads, yarn and fabric in three steps: Purification, Spinning, and Weaving.

One of the chemical purification steps of the cotton is bleaching. Main goals of the bleaching process are to obtain a white, ultimately cleaned substrate in the shortest time (highest productivity) possible with minimum fiber damage. In this stage, process reaches to high temperatures and consumes huge amount of water.

The most widely used bleaching agent is hydrogen peroxide (H_2O_2). This agent uses a form of oxygen as the oxidizing agent in the process. Decoloration can occur by breaking up the chromophore groups, most likely destroying one or more double bonds within the conjugated system. H_2O_2 is easily decomposed (Figure 1) due to its instability and the catalytic effects from metal ions present in bleaching solution, which leads to increase in running cost and damaging the cotton fiber. To improve the bleaching efficiency, many catalysts and methods have been developed to control of the H_2O_2 decomposition.

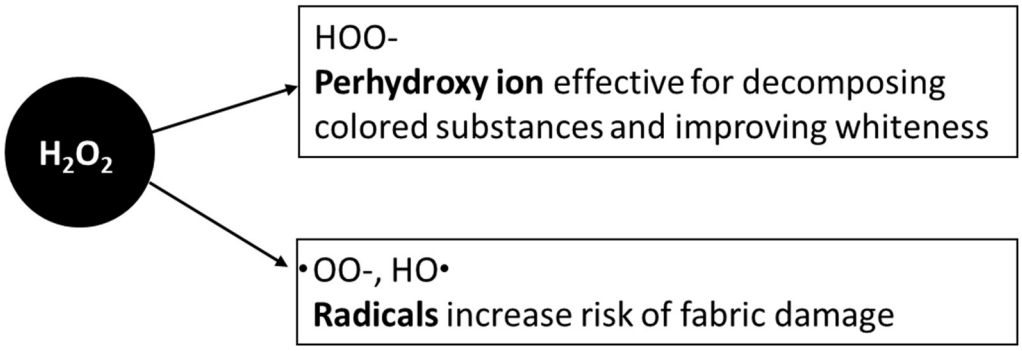


Figure 1. H_2O_2 decomposition.

Common peroxide bleaching is commonly carried at high temperature (normally ~98 °C) and pH, which causes significant fiber loss and therefor poor strength properties[2]. There is some catalyst which has been developed for mild bleaching of cotton by controlling H_2O_2 decomposition speed such as; Copper (Cu) and Ferrum (Fe).

In this work, we designed a bleaching method at lower temperature (~80 °C) stain removing by using the catalyst mixture that we developed and called AKKOMD905 which can activate and control H_2O_2 decomposition under alkaline conditions for improving traditional bleaching method. Key advantage of the AKKOMD905 based novel bleaching process is energy cost saving due to lower bleaching temperature, shorter bleaching cycle by improving production

capacity, milder processing conditions such as higher cotton yields, softer feeling cotton, less creasing in final fabric.

Consequently, eco-friendly approach towards bleaching process by using novel catalyst is developed. Here, we applied different solution recipes with and without AKKOMD905 at different temperatures as summarized in Table 1 and whiteness is shown in Figure 2. In the same bleaching application duration, whiteness index (Berger >60) value of the cotton sample reached higher values in the presence of AKKOMD905. While we were comparing different temperatures, we can reach the optimum accepted whiteness result at 80°C. Even though 98°C gives higher whiteness in cotton fabric, application temperature is too high for the sustainability aspects.

Table 1. Bleaching of Cotton Fabric with and without AKKOMD905 Catalyst

Application Temperature (ºC) and Time (min)		70°C - 45 min.		80°C - 45 min.		98°C - 45 min	
Recipe		Recipe1	Recipe2	Recipe1	Recipe2	Recipe1	Recipe2
AKKOMD905	g/L	1	-	1	-	1	-
Traditional Bleaching	g/L	-	1	-	1	-	1
Capillarity min /sec		>5 min	>5 min	15sec.	>5 min	5 sec.	5 sec.
Berger Value		67,80	61,19	71,73	67,12	76,05	74,08

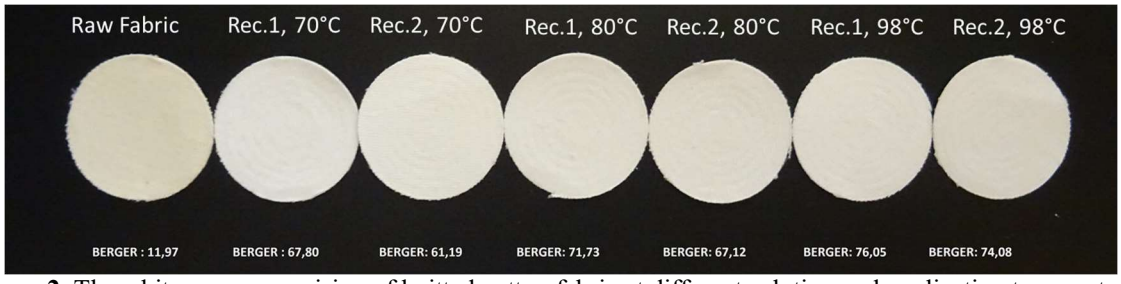


Figure 2. The whiteness comparision of knitted cotton fabric at different solution and application temperatures.

Keywords: Cotton, Bleaching, Catalyst, Sustainability.

[1] KHATRI, A. A review on developments in dyeing cotton fabrics with reactive dyes for reducing effluent pollution. Journal of Cleaner Production, 2015, vol. 87, pp 50-57.

[2] FONTANA, G. Effect of the Bleaching on Physical and Mechanical Properties of Different Fabrics. Fibers and Polymers, 2018, vol. 19, No.12 pp 2590-2596.

LIST OF AUTHORS

L

M

N

O

Ö

P

R

S

Š

Ş

XVI. IITAS

XVIth INTERNATIONAL IZMIR TEXTILE AND APPAREL SYMPOSIUM

www.iitas2023.com

Ege Üniversitesi Basımevi Müdürlüğü

E-ISBN:978-605-338-429-8