Program: RMIT AUTEX2023
Building 516, RMIT Brunswick
25 Dawson Street, Brunswick VIC AU

NOTE to ALL Attendees: To Access the Presentations, each Plenary and Session Label is a Link to Microsoft Teams meetings. Download Teams | Join on the web

Monday, 26 June 2023

Opening Ceremony Room 516.02.005

9:00 Opening remarks
Prof. Lijing Wang, Secretary, RMIT AUTEX 2023 and Session Chair
9:05 Acknowledgement of Country
Prof. Robyn Healy, Associate Deputy Vice Chancellor Learning and Teaching (DSC)
9:20 Prof. Alice Payne, Dean School of Fashion and Textiles
9:25 Prof. Tim Marshall, Deputy Vice Chancellor, College of Design and Social Context, and Vice-President
9:35 Prof. Vassiliadis Savvas, President, AUTEX
9:45 Prof. Stephen Michielsen, Co-Chair RMIT AUTEX 2023

10:00 Tea/Coffee Room 516.02.001

Plenary Session Room 516.02.005

10:30 Plenary Presentation: Prof Xungai Wang "A Century of Textile Research"
11:10 Plenary Presentation: Prof Cherif Chokri "Interactive fibre-based materials for human-machine interfaces and the tactile internet"

Session 1: Advanced Materials 516.01.009
Session Chair: Dr. Xin Wang

11:55 Jizhen Zhang "Understanding the structure-property relationship of fibres from sub-nanoscale to microscale using correlative SAXS/WAXS and Micro-CT"
12:15 Kazushi Yamada "Characterization of Nanoporous Poly(lactic acid) Microfibers Using a Simplified Centrifugal Spinning Method"

12:35 Lunch Room 516.02.001

14:00 Session Chair: Prof. Xungai Wang 516.01.009

14:00 Théo Perrin "Multi-scale investigation of the bending behaviour of the flax/polyamide fabrics"
14:20 Wafa Mahjoub "Cotton Fibers characterization depending on the fiber's microstructure"
14:40 Mahmud Hossain "In-Situ Measurement of Twist Propagation and Yarn Tension in Ring Spinning with a Superconducting Magnetic Bearing Twisting Element"
15:00 Pratibha Xin "Fabrication and characterization of Carrageenan-PEG-Lecithin Hydrogel Membranes as a Wound Dressing Material"

15:20 Tea/Beverages

15:50 Session Chair: Dr. Rebecca Van Amber 516.01.009

15:50 Yasir Nawab "Evaluating the effect of weaving pattern on the mechanical performance of auxetic 3D woven composites"
16:10 Jan Thiel "Sustainable Elastic Yarn Production"
16:30 Rumbidzai Zizhou "Melt Spinning of Elastomeric PCU Yarns"
16:50 Close

Session 2: Wearable Technologies 516.01.010
Session Chair: **Prof. Lijing Wang**

11:55 Raphael Kanyire Seidu "Interactive clothing for enhancing pedestrian safety at night"
12:15 Abher Rasheed "Effect of Thread Consumption and Ageing on the Performance of Textile-Based Embroidered Electrodes"

12:35 Lunch Room 516.02.001

14:00 Session Chair: Prof. Cherif Chokri 516.01.010
14:00 Susanne Fischer "Weft-knitted strain sensors for motion capture"
14:20 Mathi Bruns "Wet-spinning of PEDOT:PSS Fibres for use in Ionic Electroactive Actuators"
14:40 Carola H. Böhmer "Quantifying the Human Perception: Development and Characterization of Textile-Based Capacitive Strain and Pressure Sensors"
15:00 Tamaki Mitsuno "Reaction time when wearing clothing with a waistband"
15:20 Tea/Beverages

15:20 Session Chair: Prof. Steve Michielsen 516.01.010
15:50 Sayuki Kondo "Energy consumption when wearing pantyhose"
16:10 Karl Kopelmann "Simulation Supported Enhancement of the Performance of Thermoset Composite Actuators through Surface Modification of Shape Memory Alloy Wires and Development of Force-Optimized Woven Bindings"
16:30 Mustafijur Rahman "Developing Color-changing Novel Dye for pH-sensing in wounds dressing"
16:50 Close

Tuesday, 27 June 2023

Plenary Session Room 516.02.005

9:00 Prof Alice Payne "Governing the ungovernable: the regulation reshaping the fashion and textiles industries"
9:40 Dr Amit Jadhav "Textile Materials for Medical Devices: Innovations and Challenges in Design and Manufacturing"
10:20 Tea/Coffee Room 516.02.001

Session 3: Advanced Materials 516.01.009
Session Chair: Prof. Rajiv Padhye

10:50 Yong Kim "Characterization of Flocked Energy Absorbing Materials in Sport Helmet Padding"
11:10 Mohammad Mamunur Rashid "Ag Doping & rGO Coupling of TiO2 within Polysiloxane Matrix for the Ecofriendly Development of High-Performance Cotton Fabric"
11:30 Esfandiar Pakdel "Novel functionalities on cotton fabric using inorganic and bio-based ingredients"
11:50 Sven Hellmann "Novel Knit-Structure with adjustable tensile behaviour based on combined Warp and WeftKnit technology"

12:10 Ada Ferri "Simulation of Fabric Permeability and Inertial Coefficient in a Supercritical Carbon Dioxide Beam Dyeing Process"

12:30 Lunch Room 516.02.001

14:00 Session Chair: Dr. Amit Jadhav Room 516.01.009

14:00 Giuseppe Rosace "Silica-Containing Phosphorus-Based Sol-Gel Finishing to Improve Flame Retardant Performance of Cotton Fabrics"

14:20 Iris Kruppke "Parameter study on modified polyacrylonitrile based precursor fiber for carbon fiber production"

14:40 Johannes Mersch "Analysis of the influence of fiber orientations in carbon fiber-reinforced composites on their structural properties based on eddy current measurements"

15:00 Tea/Beverages Room 516.02.001

15:30 Session Chair: Dr. Xin Wang Room 516.01.009

15:30 Lars Hahn "New Approaches to 3D NCF Manufacturing"

15:50 Thomas Gereke "Micromechanical modelling of the deformation mechanisms of friction-spun yarn from recycled carbon fibres"

16:10 Mir Mohammad Badrul Hasan "Mechanical Properties of Different Yarn Structures Based on Recycled Carbon Fibre for Sustainable Thermoset Composites"

16:30 Sandeep Olhan "Effect of different machining processes on the bearing strength of pin-loaded textile composite panels for automotive: Experimental and FEM analysis"

16:50 Close

18:00 Gala Dinner Oxford Scholar

Session 4: Supply Chain/Sustainability 516.01.010

Session Chair: **Dr. Rebecca Van Amber**

10:50 Shaghayegh Arangdad "Disruptions and Adaptations: COVID-19's Impact on Textile Supply Chain Management"

11:10 Ankita Sharma "Fabrication of Antimicrobial Cotton Gauzes Immobilized with Alginate/ Glycerol/ Tannic Acid Blend"

11:30 Rangam Rajkhowa "Bio-mercerisation of cotton to improve look, handle and dyeing properties of cotton"

11:50 Lyndon Arnold "Continuous Mercerisation of Loose-Stock Cotton"

12:10 Raziye Atakan "Use of Rosa Canina Extractions in Textile Finishing"

12:30 Lunch Room 516.02.001

14:00 Session Chair: A/Prof. Rajlhowa 516.01.010

14:00 Ajoy Sarkar "Dyeing Natural Fibers with Sappanwood"

14:20 Monika Rom "Biodegradation of Sheep Wool Intended for Plant Fertilization"

14:40 Esra Gorse "Ecological Approaches in Yarn Dyeing"

15:00 Tea/Beverages Room 516.02.001

15:30 Session Chair: Prof. Steve Michielsen 516.01.010

15:30 Lucas Rosson "Retaining Colour in Regenerated Cellulose Fibres from Waste Textiles"

15:50 Matthias Overberg "Determination of the Degree of Fiber Mixing in Hybrid Yarns and Composites Based on Neural Networks"

16:10 Katarina Lindström "Investigation of Abrasive Pre-Treatment to Decrease Length Loss During Mechanical Textile Recycling"

16:30 Ainhoa Sanchez-Martinez "Influence of Laccase Enzyme on the Biodegradability of Indigo Blue Dyed Fabrics"
16:50 Close

18:00 Gala Dinner Oxford Scholar

Session 5: Future Fashion 516.02.005
Session Chair: **Dr. Carolina Quintero Rodriguez**

10:50 Jing Liu "Development of 3D Printed Fashion through Textile-based 3D Printing"
11:10 Ruth Bunford "The development of a base layer for a Sensorimotor Countermeasure Skinsuit, with attention to garment comfort and mobility"
11:30 Mega Saffira "Money Talks, Fashion Walks: A Textile Motif Exploration in Womenswear using 1960s Rupiah Banknotes"
11:50 Yingmiao Wang "The Aesthetic Factors Shaping Chinese Millennial Consumers' Purchase Intentions of Luxury Pyjamas: Implications for Future Design"
12:10 Peirong Ye "Understanding the Marketing Strategies Used by Chinese Fashion Micro-Influencers to Improve Click-Through Rates"
12:30 Lunch Room 516.02.001

14:00 Session Chair: Prof. Alice Payne 516.02.005
14:00 Aayushi Badhwar "The Intersection of Fashion and Climate: A Comparative Examination of Australian Fashion & Textile Industry's Approach to Climate Change"
14:20 Lucia Oana Secareanu "Treatment and Characterization of Cosmetotextiles with Antibacterial Activity"
14:40 Pelin Altay "Improving the Tear Strength of Low Weight Wool/Lycra Flannel Fabrics by Cordura Reinforcement"
15:00 Cut Manda Sari "Exploring Internet of Things in Higher Education: Students' Perceptions of Cognitive Benefits and Immersive Learning Experiences"
15:20 Tea/Beverages Room 516.02.001
15:50 Close

18:00 Gala Dinner Oxford Scholar

Wednesday, 28 June 2023

Plenary Session Room 516.02.005

9:00 Prof GuangmingTao "Functional Fibers Towards Intelligent Space"
9:40 Prof Behera "Design and manufacturing of advanced multifunctional textile structural composites"
10:20 Tea/Coffee

Session 6: Biomaterials 516.01.009
Session Chair: **Prof. Guangming Tao**

10:50 Vandana Kumari "Development of Electrospun Bioactive Polycaprolactone/ T. arjuna Nanofiber for Biomedical Applications"
11:10 Manali Somani "Designing of Antimicrobial Polyurethane Catheter for Prevention of Infections"
11:30 Tanushree Saha "Development of a Composite Mesh with Dual-Sided Properties for Hernia Repair"

11:50 Sabrina Kopf "Influence of hydroxyapatite particle size on PHBV fibers for bone tissue engineering"
12:10 Anna Doersam "Woven and knitted scaffolds for Tissue Engineering applications using a PCL-PLA nanofibrous core-sheath yarn"
12:30 Lunch Room 516.02.001

Session 7: Supply Chain/Sustainability 516.01.0010

Session Chair: **Prof. Behera**

10:50 Sutapa Chowdhury "What is the Potential of Circular Economy in the Fashion and Textile Industry of Bangladesh?"
11:10 Dylan Hegh "Wearing Waste"
11:30 Yi Zhang "A standard terminology for the description of fibrous microplastics from textiles"
11:50 Alessandra Sutti "Textile non-regenerated cellulose microfibres are pervasive, yet overlooked, potential pollutants in surface waters: a global study"
12:10 Zoe Mellick "Australian Cotton and the Global Apparel Supply Chain: Sustainability Issues in Context"
12:30 Lunch Room 516.02.001

FLAMME
14:00 Tour of FLAMME Facility
15:30 Tea/Beverages
16:00 Close

Poster Session 516.02.001

Xiaodong Tan
Abstract "Preparation of cellulose/graphene oxide films crosslinked by vinyltrimethoxysilane"
Poster

Xiuling Zhang
Abstract "Enhanced Side-Illumination of Etched Polymer Optical Fiber (Pof)-Incorporated Woven Polyester (Pet) Fabrics"
Poster

Esfandiar Pakdel
Abstract "Recycling carbon fibre scrap into functional nonwovens"
Poster

Duc Duong
Abstract "Developing Training from Industrial Design to Innovative Design in Vietnam"
Poster

Antoneta Tomljenović
Abstract "Influence of Linear Density of Polyamide Plating Yarn on the Usage and Comfort Properties of Men's Cotton Socks"
Poster

Lingquan Hu
Abstract "A Recycling Approach of Thermoplastic Polyurethane Films for 3D Printing Textiles"
Poster

Shenglin Cui
Abstract "Effect Evaluation of Repeated Compression for Tactile Hardening of Cotton Pile Towel by Indentation Test"
Poster

Zhang Yue

Abstract “Computational Evaluation of Weaving Process on Mechanical Stiffness of Plain Weave Fabric”
Poster

Youngjoo Chae

Abstract “Lightness and Hue Dependencies of Color Difference Thresholds in Textiles Under High-Illuminance Conditions”
Poster

Eunjou Yi

Abstract “Comfort Properties and Antimicrobial Activity of Cotton and Nylon/PU Knits Treated with Microcapsules Containing Sea Buckthorn Oil”
Poster

Ida Ljungberg

Abstract “Improved horizontal wicking test for incontinence applications”
Poster

Pelin Altay

Abstract “Performance Properties of Swimwear Fabrics Produced from Polyester and Recycled Polyester Fiber”
Poster

Anita Tarbuk

Abstract “The Durable Chitosan Finishing of Cotton and Cotton/Polyester Blended Fabrics”
Poster

Mustafijur Rahman

Abstract “Development of novel multi-layered nanocomposite scaffold for next-generation artificial nerve guide conduit”
Poster

Mareen Warncke

Abstract “Moving Smart Textiles Towards Sustainability: Environmentally Friendly Protective Coating for Electrically Conductive Yarns”
Poster

Ken Aldren Usman

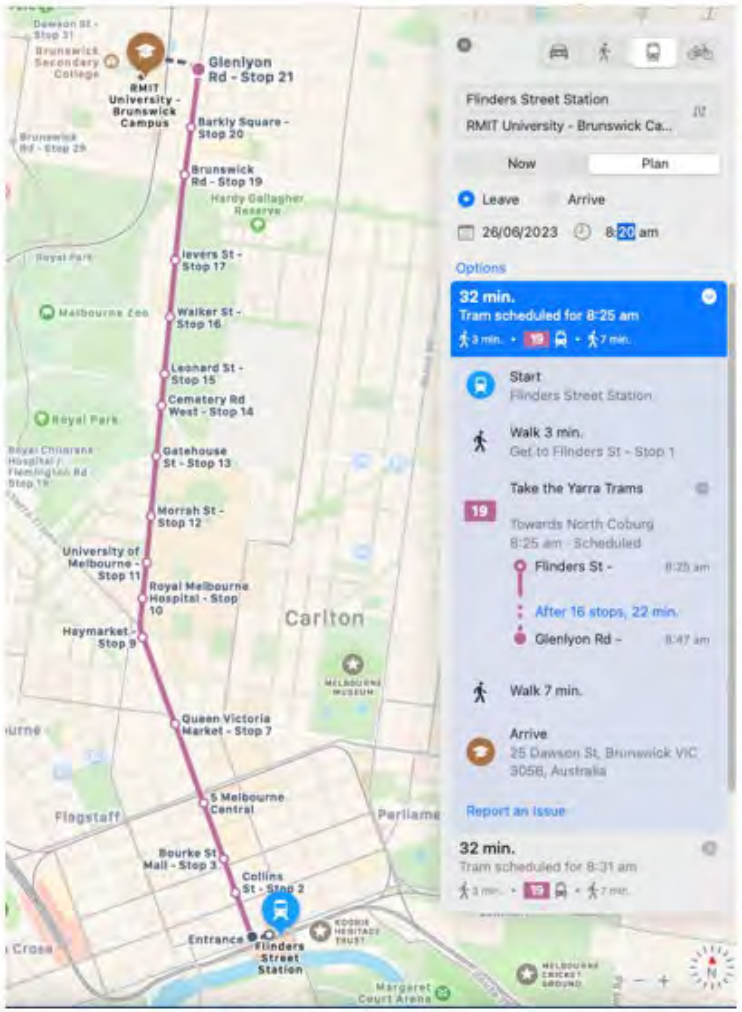
Abstract “Fabrication Strategies Towards Mxene-Based Multi-Functional Fibers”
Poster

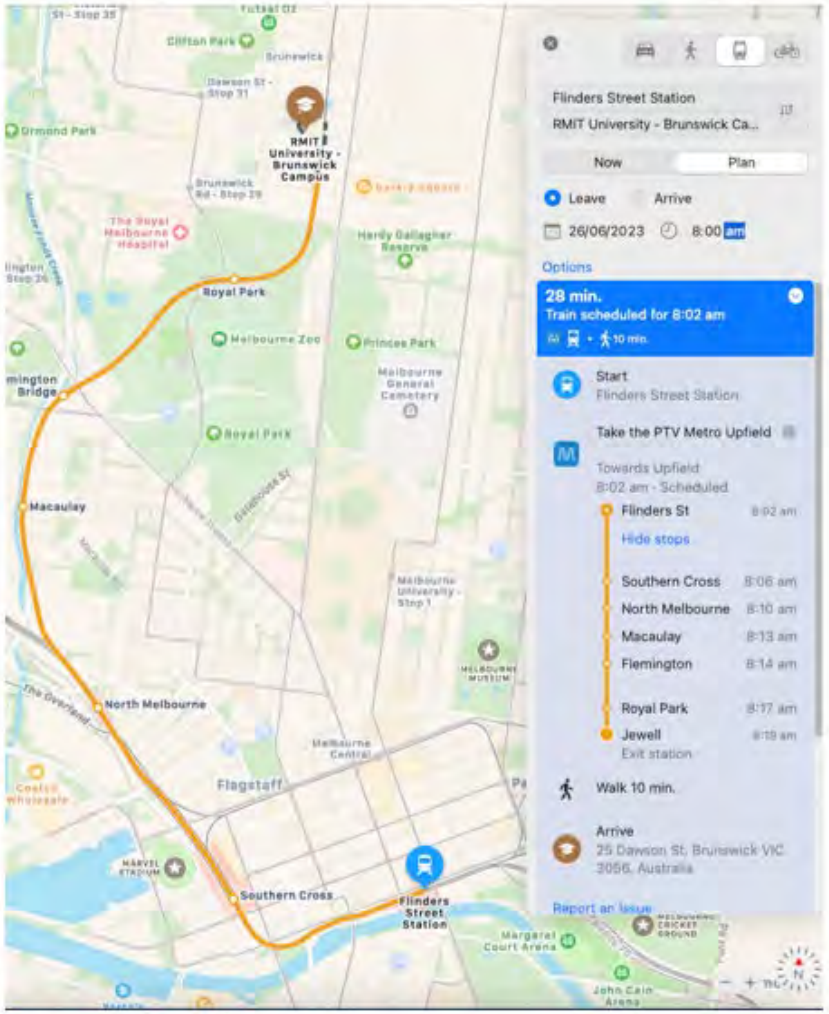
Matthias Overberg

Abstract ”Determination of the Degree of Fiber Mixing in Hybrid Yarns and Composites Based on Neural Networks”
Poster

How to get to RMIT Brunswick Campus

- **By Taxi**
  To RMIT Brunswick Campus at 25 Dawson St, Brunswick 3056
- **By Tram†**
  No. 19 to stop 21
- **By Train†**
  Upfield Line to Jewell Station

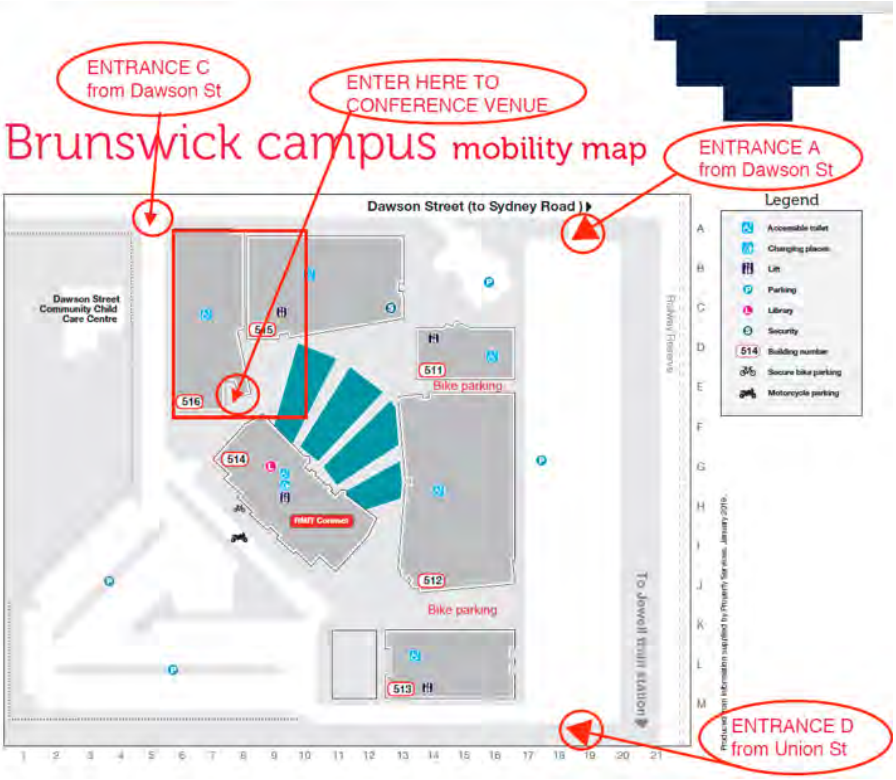




†Note: You need a Myki card to travel on public transport, i.e., tram or train. More information www.ptv.vic.gov.au
During on-site registration, we will provide a Myki card with three days' travelling fare recharged for International delegates

Campus Map

- Car packing during conference (26th June 2023 to 28th June 2023) is free.
- When reaching the boom gate, please call security using the intercom button and advise that you are attending the AUTEX Conference, Security will then open the boom gate for you to enter.
- There are plenty parking bays at Campus as shown on the Map



Prof. Xungai Wang

Professor X Wang is a Global STEM Scholar and Chair Professor of Fiber Science and Technology at the Hong Kong Polytechnic University. He is a Fellow of the Textile Institute, and a recipient of the Fiber Society Distinguished Achievement Award. Professor Wang serves as the editor-in-chief for the Journal of the Textile Institute, and as an editorial board member of major international research journals in the field. His research interests are in natural fibers, sustainable and functional fiber materials, yarn technology, novel textile processing and characterization technologies.

A Century of Textile Research

The year 1923 marked a critical juncture for the textile research community. It was the year when the Journal of the Textile Institute began to publish original research concerning fibers and textiles. It also marked a turning point in recognizing textile technology as a scientific discipline for serious research and development. Since then, fiber and textile research has flourished and permeated into many other fields, with original research findings reported in both textile and non-textile related journals. This presentation will look back at a century of textile research, and highlight some of the key works conducted by eminent scientists in the field. A collection of commentaries on these works by leading researchers will be published in a special issue of the Journal of the Textile Institute this year, to mark the 100th anniversary of the Journal publishing original textile research.

Prof. Chokri Cherif

Prof. Chokri Cherif is presently the Director of the Institute of Textile Machinery and High-Performance Material Technology (ITM) at TU Dresden. He is twice *graduated* in Mechanical Engineering and Business and Economics. After finishing both studies, he completed his Ph.D. in the field of textile technology, followed by a three years period of post-doctoral studies. After that he held key positions at Rieter Ingolstadt Spinnereimaschinenbau AG, as Technology Manager, Chief Department Manager of Development and Design and Member of the Executive Board. During his industry activities, he worked as an Assistant Professor at RWTH Aachen. In 2005, he accepted the professorship for Textile Technology at the Faculty of Mechanical Science and Engineering at TU Dresden. Since then, he has held various consultant positions for the EU as well as German research foundations and companies. Under his leadership, the ITM has received over 120 awards for excellent student theses, dissertations, and scientific projects. From 2010 - 2013 Professor Cherif was President of AUTEX. He was awarded the German Future Prize for Technology and Innovation, presented by the German President, for the joint research project ‘’Fascinating Carbon Concrete – resource-efficient, environment-friendly, slender”. He also received the Energy Globe World Award for Carbon Concrete Composites. Professor Cherif has nearly 300 national and international patents. Since 2009, he is CEO of his company TUDATEX GmbH in Dresden, Germany, and is exceptionally well-networked with numerous companies and OEM in automotive, medicine, machine construction, civil engineering and energy.

Interactive fiber-based materials for human-machine interfaces and the tactile internet

The emerging fields of switchable soft robotics and smart textiles have the potential to revolutionize the tactile internet by enabling the development of novel materials and systems that are capable of self-adaptation, sensing, and actuation. Interactive fiber rubber composites (I-FRC) are fiber-reinforced elastomer materials that are equipped with structurally integrated actuator and sensor networks. This innovative approach allows for the direct integration of actuators and sensors during the manufacturing process, resulting in a more robust and adaptable material. The development of I-FRC will enable the reversible and contactless adjustment of mechanical components, leading to a range of potential applications across various fields including soft robotics for human-machine interaction and prosthetics.

Smart textiles, on the other hand, offer a promising solution to facilitate the interaction between humans and machines in the tactile internet. These textiles can transduce motion and sense from and to the body, enabling the development of wearable devices that can adapt to the user's needs and environment. With their ability to detect and respond to environmental changes, smart textiles have the potential to improve the safety, comfort, and efficiency of various applications such as healthcare, sports, and entertainment. These scenarios include smart gloves or e-skins for remote teaching and rehabilitation.

The integration of I-FRC and smart textiles holds immense potential for the development of novel systems that are more robust, adaptable, and responsive to changing environments. The synergy between these two fields can facilitate the development of innovative materials and devices that can enhance the user experience and improve the functionality of various applications. Therefore, the exploration and development of these fields are discussed and how they further advance the tactile internet and its applications.

Prof. Alice Payne

Dr Alice Payne is a Professor and Dean of the School of Fashion and Textiles at RMIT. Her research focuses on environmental and social sustainability issues throughout the life cycle of clothing. Recent work has examined labour issues in the cotton value chain, as well as technologies to address the problem of textile waste. Alice is part of the Australian Fashion Council-led consortium designing the National Clothing Product Stewardship Scheme. She is author of the book *Designing Fashion's Future*, co-editor of *Global Perspectives on Sustainable Fashion*, and is an award-winning designer and educator.

Governing the ungovernable: the regulation reshaping the fashion and textiles industries

The fashion and textiles industries are under global pressure to address the social and environmental harms caused by their products. From human rights due diligence regulation to extended producer responsibility, governments are now acting. Yet how effective are these forms of regulation within a boundaryless, globalised world? This talk examines the key regulatory trends and their implications for industry.

Dr. Amit Jadhav

Dr Amit Jadhav is a Lead Textile Engineer in a Textile Centre of Excellence (CoE) at ResMed Ltd, Singapore since 2019. He is an experienced Material Scientist with a demonstrated history of working on Advanced Textile Materials for more than 15 years. He is passionate about the development of new textile-based products through design, concepts and their translation from research to industrial platforms. Currently, he leads technology driven projects to scope out new materials, innovative processes and manufacturing technologies to develop next generation textile based medical devices. Prior to ResMed, he was working in the Centre for Materials Innovation and Future Fashion (CMIFF) at RMIT University. During his tenure he commercialised patented laser ablation technology for automotive textiles, which was recognised as a one of the successful case studies for research commercialisation in Australia. He was also involved in several research projects in the area of advanced performance textiles. Throughout his career, Dr Amit has remained committed to pushing the boundaries of textile engineering, and his work has had a significant impact on the industry. His passion for innovation and dedication to advancing the field make him a valuable contributor to the textile research & development community. He is an avid researcher, having developed few patents and publications related to advanced textile materials/technologies. Dr Amit holds a PhD degree from RMIT University, Australia and MSc degree from University of Leeds, UK. He was awarded the prestigious Endeavour Scholarship and British Chevening Scholarship for his PhD and Master studies respectively.

Textile Materials for Medical Devices: Innovations and Challenges in Design and Manufacturing

Textiles are increasingly being used in the design and manufacture of medical devices due to their unique properties such as flexibility, breathability, touch and feel properties. However, the use of textile materials in medical devices presents several challenges related to material selection, design, manufacturing, testing, and regulatory compliance. This talk will discuss the process of developing textile components for a medical device from concept to user. This process involves many cross functional teams at every stage of development. It also examines the application of textile fabrics from various textile manufacturing technologies, including their properties, advantages, and limitations. In addition, the regulatory landscape for medical textiles and the importance of ensuring the safety and efficacy of textile-based components for medical devices will be discussed. This talk aims to provide insights into the design and development of textile-based medical devices and highlight the opportunities and challenges in this field.

Prof. Guangming Tao

Guangming Tao is a Professor of Wuhan National Laboratory of Optoelectronics, and the School of Materials Science and Engineering, the Director of Sports and Health Initiative, Optics Valley Laboratory, Huazhong University of Science and Technology. His research interests include interdisciplinary research on passive thermal management materials, intelligent fiber and fabric space, and minimally invasive medical fiberbot. He has published 90+ papers in journals including Science and more, holds 38+ granted and 46+ pending patents. Professor Tao's research group received 2021 Award for China's Top 10 Optical Breakthroughs, Top 10 Social Impact Events in China's Optics Field in 2021, and the Candidate Projects of China Issues Top 10 Scientific Advances of 2021, etc. He is currently the Deputy Director of the Division of Fiber Materials and Composite Technology of China Materials Research Society, Associate Editor of Advanced Fiber Materials, Editorial Board member of Journal of Textile Research, Director of the Third Youth Editorial Board of China Laser Press.

Functional Fibers Towards Intelligent Space

Functional fiber materials and devices shed a new light on intelligent matter. By integrating multifunctional materials into flexible fibers and their assemblies, the dynamic multi-physical parameters in the human-matter interactions are acquired and regulated. It is of great significance to explore precise and scalable fabrication of functional fiber materials and devices for embodied intelligence in diverse environments. This talk will present our recent progress on functional fibers for intelligent space: 1) It will highlight the scalable daytime radiative cooling with the hierarchical-morphology metafabrics, inducing a temperature difference of ~5°C on body, and ~30°C on car model. 2) A new strategy of electronic fabrics with digital perception is discussed. The interactive accuracy of up to 96% of the electronic fabric was achieved with a designable and scalable braided electronic cord. 3) An intuitive medical robot, called fiberbots, is briefly introduced, and the collaborative design of precise navigation and energy delivery enabled a navigation-tasking-recycling interventional platform *in vivo*.

Prof. Bijoya Kumar Behera

Dr B. K. Behera is working as professor in the Department of Textile and Fibre Engineering, Indian Institute of Technology Delhi. His area of specialization includes Fabric manufacturing, 3D weaving and Braiding, Apparel Engineering and Quality control, Fabric Hand, Project Management, Textile Structural Composites and Concretes and Mechanics of Textile Structure. His Current research interest includes Design and manufacturing of Textile structural composites and concretes, Auxetic Weaving, Green composites, 3D weaving, Protective Clothing, Automotive Textiles. Prof. Behera has authored more than 300 peer-reviewed papers and delivered more than 350 talks in various international conferences and symposia including 70 plenary and invited speech in international conferences. He has authored, co-authored and chapter contributions in 15 books relating to Textile structural Mechanics, Soft computing in Textiles and Weaving Technology. Prof. Behera has supervised 30 PhD and 70 Master thesis. He has seven patents to his credit. Prof. Behera has successfully completed 25 sponsored research projects and more than 75 industrial consultancy projects as principal investigator. At present he is chief of a Focus Incubation Center in 3D weaving and Structural composites supported by Ministry of Textiles. He has also worked as visiting professor in Shinshu university Japan, Technical university of Liberec, Czech Republic and University of Sao Paul, Brazil and Usak university Turkey. He has been an invited speaker in many foreign universities and institutions which includes Shinshu University Japan, Technical university Liberec, VUTS research centre Czech Republic, Promatech Machinery Research centre Italy, Composite research institute Budapest, Sao Paulo university Brazil. Prof. Behera is member of governing council of several reputed Textile institutions and member of Board of studies in five Technical universities. Prof. Behera has a very strong interaction with several reputed textile industries in India in the capacity of a consultant. He is also member of Board of Directors of three reputed textile companies in India.

Design and manufacturing of advanced multifunctional textile structural composites

Novel materials with unique properties compared to conventional materials are named as advanced materials that help modern industries to drive technological innovations and optimise the cost and efficiency of existing traditional materials and products. These materials include biomaterials, smart materials, nano-engineered materials, auxetic materials, smart composites for structural health monitoring, structural power composites, and a large variety of advanced textile structural composite materials. This paper presents development of textile structural composites as a new class of high-performance functional materials in the Focus incubation centre of IIT Delhi where the emphasis is given to produce innovative fibre architecture in manufacturing of tough, net shape, damage resistance, ductile, light weight multifunctional structural composites. The toughening and strengthening of polymer, metal, and ceramic matrix composites through the use of 3-D fibre architecture is demonstrated with experimental evidence. Number of experimental investigations revealed the potential of 3D textile structural composites to be used in automotives, aerospace, marine, wind energy and civil engineering applications. Techniques for the modelling of textile structural composite for their mechanical performance are also illustrated with examples in specific applications. Engineering design and manufacturing of woven auxetic composites, metal matrix fibre reinforced composites, multifunctional structural power composite, metal laminates/sandwich materials, woven structural composite radome and several 3D woven structure based composites are discussed with experimental results of their structural and non-structural functions.

Understanding the structure-property relationship of fibres from sub-nanoscale to microscale using correlative SAXS/WAXS and Micro-CT

Jizhen Zhang[1,2], Sitarama Kada[1,2], Peter Lynch[1,2], Joselito Razal[1]
[1]Deakin University, Waurn Ponds, Australia. [2]CSIRO Manufacturing, Waurn Ponds, Australia

Abstract

Functional fibres are fibres with a set of integrated functions of controlling or adjusting according to its application. Such fibres are normally produced with functional materials or their composite, which requires precise structural engineering to realize the properties from sub-nanoscale to microscale. This also requires a series of advanced characterization methods to reveal the structural information at different scales. As an example, the 2D nanomaterial MXene recently gained enormous attention due to its unusual mix of electrical conductivity, large surface area, and good dispersibility in a variety of liquids. In order to create functional fibres from nanomaterials, wet-spinning is one of the most favoured method because to the superior dispersibility od MXene in solvents. In our studies, the highly electrical conducting pure MXene fibre and composite fibre are spun from their dispersions and SAXS/WAXS is introduced to reveal the orientation of MXene sheets in different spinning conditions. Additionally, the SAXS/WAXS investigation shows that MXene nanosheet alignment and orientation have a significant impact on the properties of their macrostructures. On the other dimensions, X-ray micro-Computed Tomography (CT) measurement is performed to investigate the defects in the carbon composite material. Using optimised image processing methods, the orientation and volume of the defects, composites and woven fibres used for stitching composites are quantified. In summary, the successful coordination of SAXS/WAXS and micro-CT offers an opportunity to bridge the gap between structural preparation and structural performances.

Characterization of Nanoporous Poly(lactic acid) Microfibers Using a Simplified Centrifugal Spinning Method

Kazushi Yamada[1], Chieko Narita[2]
[1]Kyoto Institute of Technology, Kyoto, Japan. [2]Kyoto Sangyo University, Kyoto, Japan

Abstract

In recent years, great attention has been paid to the development of porous materials with excellent reactivity and absorbency. We have successfully prepared poly(lactic acid) (PLA) microfibers with uniform nanopores by rotary centrifugal spinning using PLA/chloroform solution. Our previous research showed that PLA microfibers have extremely high oil absorbing capacity. In this study, we systematically evaluated the changes in fiber diameter and nanopore size of these nanoporous PLA microfibers under different fabrication conditions and the adsorption capacity of Prussian blue nanoparticles. The results showed that the fiber diameter increased with increasing PLA/chloroform solution concentration. Furthermore, it was found that the amount of adsorbed Prussian blue nanoparticles increased with the increase in fiber diameter. Prussian blue nanoparticles are known to adsorb radioactive materials such as cesium, and are expected to be applied to the recovery of cesium diffused in the atmosphere and ocean.

Multi-scale investigation of the bending behaviour of the flax/polyamide fabrics

Théo Perrin, Gilles Arnold, Michel Tourlonias, Karine Gautier, Peng Wang
UHA, Mulhouse, France

Abstract

Process-induced defects are one of the causes of the variability of composite structures. As the fabrics used are usually made of rigid materials, it is the fabric's structure that has to deform when the mould pressure is applied, mostly by in-plane shearing and bending. The present study focuses on the bending behaviour of fabrics during the forming stage in Resin Transfer Moulding process. The fabrics are made with a comingled flax and PA12 yarns that has been twisted with a PA12 multifilament to reduce friction during weaving. The selected textile structures are the satin, 2-2 twill[1] and 4-4 twill.

A Pierce Cantilever test[2] has been modified to enable the measurement of the bending rigidity at the high temperatures. A camera will take pictures of the hanging yarns or fabrics in an oven[3]. The image analysis will determine the curvature and the moment of bending at each point of the material[4]. The impact of shearing in the fabric or tension in the yarns on the bending behaviour will also be discussed in this study.

Cotton Fibers characterization depending on the fiber's microstructure

Wafa Mahjoub[1], Omar HARZALLAH[1], Sophie Bistac[2]
[1]ENSISA LPMT, MYLHOUSE, France. [2]LPIM, MULHOUSE, France

Abstract

In this work, we investigate the cotton fibers behavior in the yarns assemblies taking into account the microstructure of cotton. The aim is to establish the relationships between the yarn and single fibers properties. This study was focused on the creep behavior of yarn cotton fibers. Results showed that cotton fibers are viscoelastic and their creep response in yarn assemblies fits to a four-element model; the Burgers model. Furthermore, Dynamic Mechanical Analysis (DMA) tests have been carried out to understand the fiber's interactions and microstructure.

Fabrication and characterization of Carrageenan-PEG-Lecithin Hydrogel Membranes as a Wound Dressing Material.

Pratibha Singh[1], Chetna Verma[2], Samrat Mukhopadhyay[1], Amlan Gupta[3], Bhuvanesh Gupta[1]
[1]IIT Delhi, Delhi, India. [2]IIT DELHI, Delhi, India. [3]SMIMS, Sikkim, India

Abstract

The skin tissue is vulnerable to external damages, which if left untreated can cause bacterial adhesion and colonisation, which will deteriorate wound healing process. Hydrogels as a wound dressings have attracted much attention because they provide moist and soothing environment at the wound interface. Carrageenan (CG) holds several unique properties, such as high biocompatibility, gel-forming ability, high exudate absorptive capacity, and capability to provide an adequate moist wound healing environment. However, owing to the inferior mechanical properties, the direct application of CG as a wound dressing has been limited. Thus, physical blending using naturally occurring polymers has emerged as an attractive, and inexpensive approach for endowing CG-based hydrogels with desirable properties for the wound management.

Herein, hydrogel membranes composed of CG, PEG and phosphatidylcholine lipid, soy lecithin (LC) were fabricated, which can provide an optimal moist environment, mechanical performance, and superior antioxidant and antifouling properties. In the present study, CG-PEG/LC mass ratio was varied to fabricate a series of hydrogel membranes via a

facile solution casting methodology approach. The physicochemical properties of the fabricated hydrogel membranes were analyzed through SEM, FTIR, XRD, and mechanical measurements. The resulted hydrogel membranes exhibited superior antioxidant properties which can effectively alleviated the wound site's oxidative stress. Moreover, due to the antifouling property of both PEG and LC, the biointerface of the hydrogel membrane showed superior antibacterial adhesion activity against both S. aureus and E. coli. Hence, the present hydrogel membranes hold immense potential as an excellent wound dressing material in the healthcare sector.

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Abstract

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IN-SITU MEASUREMENT OF TWIST PROPAGATION AND YARN TENSION IN RING SPINNING WITH A SUPERCONDUCTING MAGNETIC BEARING TWISTING ELEMENT

Mahmud Hossain[1], Anwar Abdkader[1], Chokri Cherif[1], Mostafa Baloochi[2], Ruben Hühne[2], Yves Jesus Perez Delgado[3], Michael Beitelschmidt[3]
[1]Institute of Textile Machinery and High Performance Material Technology (ITM), Technische Universität Dresden, Dresden, Germany, Dresden, Germany. [2]Leibniz IFW Dresden, Institute for Metallic Materials, Helmholtzstrasse 20, 01069 Dresden, Germany, Dresden, Germany. [3]Institute of Solid Mechanics (IFKM), Technische Universität Dresden, 01062 Dresden, Germany, Dresden, Germany

Abstract

The twisting of yarn in one of the most widely used conventional ring spinning processes is based on the ring/traveler system. Recently, a frictional free twisting element based on a superconducting magnetic bearing (SMB) was developed to increase the productivity of ring spinning drastically, which is patented by ITM and Leibniz IFW Dresden. This SMB consists of a circular superconductor and a permanent magnet (PM) ring. In the superconducting state, the PM ring levitates and can freely rotate even up to an angular speed of 50.000 rpm. It is connected with the spindle via the yarn through a guide attached to the PM ring to impart yarn twist. Through the rotation of the PM ring, the twist propagates to the nip point of the delivery rollers. A change in the level of twist affects the process, yarn tension, yarn breakage rate, and yarn properties. Hence, it is important to investigate the twist distribution to derive effective measures for improving the twist propagation and thus eliminate weak points to increase process stability and yarn quality.

The aim of these measurements is to analyze the twist distribution along the yarn path to understand the causes of yarn breakages. In this study, the yarn path is traced at different regions by in-situ measuring the helix angle of twisted yarn fibers and the yarn diameter using a high-speed camera. From the recorded images, the number of twists per unit length is determined using the image processing software 'Image J' with a developed algorithm.

Evaluating the effect of weaving pattern on the mechanical performance of auxetic 3D woven composites

Tehseen Ullah, Muhammad Umair, Muzzamal Hussain, Yasir Nawab
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Abstract

Natural fiber-reinforced polymer composites (NFRPC) are gaining increasing attention as environmentally friendly, lightweight, biodegradable, and cost-effective materials. However, their inferior mechanical properties remain a challenge. Auxetic woven reinforcement are produced by placing the yarns in a certain pattern in the fabric during weaving. These fabrics show negative Poisson's ratio when subjected to tensile load.

This study explores the potential of jute-based 3D woven auxetic structures as reinforcement for NFRPCs. Three different layer-to-layer orthogonal woven structures i.e., warp, weft and bi-directional interlock were developed and used as reinforcement with thermoplastic matrices i.e., polycarbonate (PC) and polyvinyl butyral (PVB) to develop composites. Tests were performed on both the reinforcement level (auxeticity, tensile, tear, stiffness) and the composite level (flexural, Charpy, and Drop weight impact). The results showed that the warp interlock structure had the highest auxeticity, while the bi-directional interlock structure had the lowest auxeticity. At the reinforcement level, the warp interlock structure demonstrated superior mechanical properties than rest of samples due to its higher auxetic nature. In composite samples, with PC resin, having higher auxeticity of reinforcement, increased the tensile and flexural strength up to 47% and 49.5% respectively, whereas impact energy and impact strength increased up to 35% and 70% respectively compared to the lower auxetic reinforcement. PVB-based composite samples with higher auxetic reinforcement increased the tensile and flexural strength up to 43.6% and 52% respectively, and in the case of impact energy and impact strength, the increase was 60.7% and 60.37% respectively, compared to lower auxetic reinforcement.

Sustainable Elastic Yarn Production

Jan Thiel[1], Rumbidzai Zizhou[2], Henning Löcken[1], Shadi Houshyar[3], Rajiv Padhye[2], Lukasz Debicki[1], Xin Wang[3]
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Abstract

The exhaust gas carbon dioxide (CO2) is an abundant, sustainable and, in comparison to many biogenic raw materials, inexpensive feedstock for the production of polymers. Technologies exist for utilising CO2 for the production of polyols that can be used in thermoplastic polyurethanes (TPU). First elastic filament yarns from these CO2-TPU could already be spun on pilot scale and transferred to textile applications. However, the developed yarns have a particular tackiness, which still poses challenges in further processing and thus makes industrialisation difficult. Additionally, the mechanical yarn properties allow at most the use for softstretch and must be extended for further applications. The global market for elastic filaments will grow at a rate of 8 % per year and is expected to reach a volume of 1.5 million tonnes by 2023. Elastic filaments are used in 80 % of all clothing products and are thus a globally significant economic factor for the textile industry. In this conference paper, major challenges in processing TPU by melt spinning are displayed and exemplarily discussed.

Melt Spinning of Elastomeric PCU Yarns

Rumbidzai Zizhou[1], Jan Thiel[2], Henning Loecken[2], Lukasz Debicki[2], Shadi Houshyar[3], Rajiv Padhye[1], Xin Wang[1]
[1]CMIFF-RMIT University, Melbourne, Australia. [2]ITA – Institut für Textiltechnik der RWTH Aachen University, Aachen, Germany. [3]RMIT University, Melbourne, Australia

Abstract

The ongoing environmental challenges with greenhouse gas emissions and global warming have requested the transformation of textile manufacturing into a more sustainable approach which includes carbon dioxide capture and utilisation. In this work, polyurethane yarns were produced by melt-spinning from raw material incorporating emitted carbon dioxide as feedstock to reduce the effects of processing waste on the environment and to eliminate chemical solvents used in wet-processing. The optimisation of the melt spinning process by varying parameters such as spinning temperature, shear rate and drawing ratio and their impact on the morphological structure, thermal stability and tensile properties of the fabricated multifilament yarns were studied. Characterisation of the yarns was conducted with x-ray diffraction, differential scanning calorimetry, scanning electron microscope and dynamic mechanical analyser. Results showed that the melting temperature had a significant impact on the tensile properties of the yarns, with the elongation at rupture and ultimate tensile strength being the most affected. The crystal structure of the filament yarns was then studied in relation to the processing parameters and results showed that changing the melting temperature and drawing ratio alters the crystallinity of the yarns in terms of crystal size and orientation. The effect of post drawing at three different temperatures was then simulated with the dynamic mechanic analyser, results showed no significant effect between the melt processing parameters and the strain recovery after post drawing.

Interactive clothing for enhancing pedestrian safety at night

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Abstract

Pedestrian safety on the road remains an important phenomenon at night-time. Pedestrian accidents are higher at night-time as compared to day-time. This is largely due to the clothes worn and the condition of darkness which places difficulty on pedestrian's visibility and drivers' vision at night-time. The emergence of smart and intelligent technologies for textiles have improved advancement to produce smart clothing for improved safety and protection. In this ongoing research work, an interactive clothing system is conceived and developed to enhance the visibility and alert features for pedestrians. Preliminary results demonstrate the ability to integrate LEDs on conductive yarns which are combined with micro-controllers and sensors to produce safety alert features of vibration, lighting, and sound. It was shown that, the developed output proved a preliminary success for further research geared towards enhancing night-time safety for pedestrians.

Keywords: pedestrians, safety and visibility, interactive clothing, night-time

Effect of Thread Consumption and Ageing on the Performance of Textile-Based Embroidered Electrodes

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Abstract

The integration of textile electrodes into garments for the detection of human bio-signals is becoming increasingly common. Various techniques, such as knitting, weaving, and stitching, are employed to integrate electrodes into garments. Technical embroidery, however, is a technique that may offer superior-quality electrodes. In this study, we evaluated the combined impact of cyclic loading and home laundering on the impedance of embroidered electrodes. Two types of conductive threads and two types of substrate fabrics were used to develop the electrodes, with three different thread consumptions. A cyclic loading test was conducted using a Universal Testing Machine, and a home laundering test was performed using a Launder-o-meter. The impedance of the electrodes was measured after the cyclic loading and washing tests. The results indicate that cyclic loading has a negligible effect on the impedance of embroidered electrodes, whereas home laundering affects both the impedance and surface morphology of the electrodes.

Weft-knitted strain sensors for motion capture

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ITM, TU Dresden, Dresden, Germany

Abstract

Motion caption, especially of the knee angle, is an important component for situational triggering of functional electrical stimulation (FES). One major disadvantage of commercial FES devices is their bulky design that prevents unobtrusive wearing in everyday life and limits the patient's free choice of appearance. This paper presents an alternative approach of sensors for motion caption in form of textile-based strain sensors. Those can be integrated in a FES system in form of functional leggings, which makes the FES system suitable for an unobtrusive daily use. Textile sensors, especially knitted sensors have already proven to be very promising to detect tensile strain. In particular, weft-knitted strain sensors, which can be integrated directly into the clothing during the knitting process, have the potential to detect the knee angle and therefore derive the gait phase due to the bending of the limbs without disturbing the wearer unnecessarily. Different designs of the weft-knitted strain sensor and their influence on sensor's measurement behaviour have been investigated. The weft-knitted strain sensor can be directly integrated in the knee area of the functional leggings to be used as a soft trigger to initiate electrical impulses for FES.

Wet-spinning of PEDOT:PSS Fibres for use in Ionic Electroactive Actuators

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Abstract

Intelligent textiles with integrated sensor actuator functions are a major trend in the textile industry, as they represent the combination of textile technology as an ancient and central technology of humankind with the latest megatrends in technology, namely digitalisation and robotics.

Conductive fibres are a major building block of this trend. Whereas electrical conductivity is usually achieved by coating with conducting materials or blending in conductive particles like carbon nanotubes. Abrasion or insufficient agglomeration of the conductive particles prevent their unrestricted textile processing and use as reliable sensor materials. Conjugated polymers such as PEDOT, which are intrinsically electrically conductive, have the potential to overcome these deficiencies. This work deals with the wet-spinning of PEDOT:PSS fibres as a manufacturing method of novel fibre material for the use in smart textiles like strain sensing textiles or as polymeric supply lines for peripheral devices close to the body, e.g. for health condition monitoring. Additionally, the fibres can be used as position sensors or as carrier materials for artificial muscles in the growing marked of interactive fibre rubber composites (iFRC). The spinning process is presented, mechanical and electrical properties are given and potential applications as a novel, intelligent material is discussed, in particular with regard to the use in fibrous ionic electroactive polymer (iEAP) actuators as drivers for iFRC.

QUANTIFYING THE HUMAN PERCEPTION: DEVELOPMENT AND CHARACTERIZATION OF TEXTILE-BASED CAPACITIVE STRAIN AND PRESSURE SENSORS

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Institute of Textile Machinery and High Performance Material Technology, Dresden, Germany

Abstract

In the research field of smart textiles one main goal concerns the quantification of environmental forces acting on the body. Integrating strain and pressure sensors into wearables promises a simple way of monitoring a person's posture and forces acting on their body. Sensors relying on a capacitive measuring principle are highly suitable for this, as they are less sensitive to changes in temperature.

In this paper, textile-based capacitive sensors are produced by braiding conductive yarns with and without an electrically insulating TPU-sheath. The produced sensors are analysed in cyclic strain and compression tests. Their behaviour under changing temperatures is tested as well. To extend their capabilities from an integral measurement to a localized assessment of the strain, time-domain-reflectometry (TDR) is employed. Finally, the sensors are integrated into a flexible actuated bending beam and their adoption for soft robotics is discussed.

Both measuring scenarios – pressure and strain – are tested cyclically showing good long-term stability. No change of note in capacitance is measured under changing temperature. TDR is used to localize strain in two discreet sections of the sensor. Although strain could not be quantified through TDR, characteristic points in measured response signal indicating the position of the strain were identified.

Textile-based capacitive sensors are suitable for both strain up to 10% and pressure up to 8N. The determined gauge factors are satisfactory. Furthermore, the sensors display good long-term stability and no adverse reaction to changes in temperature. TDR is proven to provide a localization of strain in flexible sensors.

Reaction time when wearing clothing with a waistband

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Abstract

Clothing pressure on the abdomen when wearing a waistband varies depending on the design of the clothing worn and the condition of the abdomen. In this study, using reaction time as an index, we investigated changes in reaction time according to whether a waistband was worn and the effect of abdominal compression intensity. Participants comprised 25 healthy right-handed young women. For simple reaction time, there were no significant differences between the right and left hands or legs. However, there were significant differences between hands and legs. For reaction time involving a choice, there were significant differences between the right and left leg and between the left hand and legs; there were also significant differences between the right hand and both legs or the left hand. The simple reaction time of the hands and legs was significantly faster than the choice reaction time. This is thought to be owing to the dual mental task of identifying the color of a flashing light and judging whether to press a button during the activity involving a choice. Compared with simple reaction times of the hands and the feet, there was no significant difference among three conditions: no waistband or normal and tight waistband compression. However, choice reaction time was significantly accelerated in the hands and the legs when wearing a waistband. Especially for the right hand and left foot, the greater the waistband pressure, the faster the choice reaction time.

Energy consumption when wearing pantyhose

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Abstract

The goal of the current study was to develop pantyhose that reduces leg muscle fatigue and energy consumption when wearing heeled shoes. To achieve this goal, a pantyhose that provides a comfortable fitting sensation were developed, and the wear experience of the product and its effect on the energy consumption under the walking muscle activity of the lower limbs was investigated. The study participants were 17 healthy Japanese females in their twenties who did not usually put on support wear. The respiratory metabolism was then measured as the participants either walked with bare feet or while wearing one of the two types of pantyhose and three types of shoes: running/low-heeled/high-heeled shoes. Participants walked on a treadmill at 3 km/h for a certain period. Regardless of whether to wear pantyhose or not, energy consumption increased significantly by walking. During walking, energy consumption increased significantly in the order of barefoot, wearing running shoes, low-heeled shoes, and high-heeled shoes. In other words, the higher the heel height, the higher the energy consumption, regardless of whether the pantyhose was worn or not. Wearing pantyhose while standing upright increased energy consumption, especially in pantyhose A, which was significantly higher than barefoot. Also, when walking in running shoes, energy consumption increased significantly when wearing pantyhose A than barefoot. In this way, it was found that just wearing pantyhose A increased energy consumption.

Simulation supported Enhancement of the Performance of thermoset Composite Actuators through Surface Modification of Shape Memory Alloy Wires and Development of Force-Optimized Woven Bindings

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Abstract

The integration of Shape Memory Alloy (SMA) wires in thermoset composites requires rigid links to the textile reinforcement for force transmission and areas of reduced stiffness for high active deformation. Approaches of different scale are evaluated within the scope of this work to reach these objectives.

The interface between actuator and composite is treated with mechanical and chemical methods. Through pull-out tests the local interface shear strength is evaluated. Furthermore, braids are developed using SMA wires as core material. These allow for locally adjusted properties to specifically tailor the behavior to smart material applications.

A new woven textile reinforcement is developed to integrate the SMA wires. Therefore, the multi-ply fabric offers regions of high thickness for excellent force transmission and single- or dual-ply areas for increased bending rates. The SMA wires are integrated as a weft yarn and do not require any additional assembly processes. These new structures are characterized by pull-out tests and thermal investigations to evaluate the performance under high switching rates.

The development is supported by the results of FEM simulations that use specific SMA models and allow for early decisions in the search of suitable woven structures. The simulation is continuously improved with the experimental results.

The results of this work provide information on how a composite structure can be integrally adapted to offer a high performance in combination with SMA wires. In addition, insights are presented how the involved temperature changes influence both SMA and composite.

Developing color-changing novel dye for pH-sensing in wounds dressing

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Abstract

Chromic textiles change color in response to external elements, making them valuable as indicator sensors. Among all chromic textile substrates, halochromic textiles, where the color of the substrate changes with the alteration of pH, provide enormous capabilities. The integration of halochromic dye on wound dressing as pH indicator might allow for non-invasive monitoring of healing progress as the pH of skin shifts during the process, eliminating the need for dressing removal. This research focuses on the development of a novel reactive dye specifically designed for application on wound dressings as a pH indicator. The color change of the dye has been observed in both the solution state and colored fabric stage, using various pH solutions. The synthesized dye demonstrates a noticeable alteration in color across different pH levels, highlighting its potential as a pH indicator on wound dressings. By utilizing the novel dye, monitoring the healing process becomes more convenient and non-invasive, as the color change of the dye can indicate the pH changes in the wound area without necessitating the removal of the dressing. This advancement has promising implications for wound care, enabling healthcare professionals to assess the progress of healing without disrupting the wound dressing. In summary, this research contributes to the development of a novel dye that exhibits significant color changes in response to alterations in pH. This dye holds promise for application as a pH indicator on wound dressings, offering a valuable tool for monitoring the healing process in a non-invasive and efficient manner.

Characterization of Flocked Energy Absorbing Materials in Sport Helmet Padding

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Abstract

A comprehensive experimental impact characterization study of novel impact energy absorbing (IEA) materials for sport helmet pads is conducted. These novel Flocked Energy Absorbing Material (FEAM) IEA panels are prepared by flocking textile flock fibers onto a fabric substrate. Here, the deposited flocked fibers are oriented upright to the direction of compressional impact such that energy absorption occurs by the bending, buckling and inter-fiber friction of the upright flock fibers during deformation by impact loading. Various FEAM pad configurations of the fiber material properties such as flock fiber length, diameter (denier), and flock density (number of flock fibers per area) were tested directly via a double lap shear jig and guided weight drop tower. IEA results of a parametric study are reported discussed, and compared with common vinyl nitrile (VN) foam. Padding material based on FEAM configurations showed remarkable improvement when compared directly to VN foam under pre-compression and dynamic shear loading, with a 135% increase in shear strain energy density for the high impact velocity loading condition. Additionally, for low velocity impact conditions, the FEAM based padding materials outperformed with a 49% increase in shear strain energy density as compared to VN foam.

Ag DOPING AND rGO COUPLING OF TiO_2 WITHIN POLYSILOXANE MATRIX FOR THE ECOFRIENDLY DEVELOPMENT OF HIGH-PERFORMANCE COTTON FABRIC

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Abstract

In this work, TiO_2 was applied to cotton fabric by a sol–gel-hydrothermal process. A combination of 3-(trihydroxysilyl) propyl methylphosphonate monosodium salt solution (TPMP) and (3-aminopropyl)triethoxysilane (APTES) was used as a matrix to enhance the interfacial interaction between TiO_2 and surface of the cotton fibres. During the hydrothermal treatment, silver nitrate ($AgNO_3$) or reduced graphene oxide (rGO) were added to produce Ag-doped TiO_2- or rGO-coupled TiO_2-coated textiles. The successful application of all investigated components on cotton fabric was confirmed by the analysis of SEM and EDS. The results of UPF determination and self-cleaning activity showed excellent performance of both studied nanocomposite coatings, whereas the use of rGO proved to be better than Ag.

Novel functionalities on cotton fabric using inorganic and bio-based ingredients

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Abstract

Durable PDMS-based coatings were applied to cotton fabrics to obtain novel functionalities of superhydrophobicity, antibacterial activity, photothermal and photocatalytic-self-cleaning. These properties were achieved through developing three types of coatings containing flower-like TiO2 particles, silver nanoparticles (Ag NPs), and bio-based natural melanin (NM) particles. Systematic investigations were conducted to understand the efficiency of each of these ingredients in obtaining the mentioned functionalities. The presence of flower-like TiO2 gave rise to an effective photocatalytic self-cleaning with the capability of removing oil-based stains under the irradiation of either visible or UV light. Simultaneously, the fabric was highly superhydrophobic and successfully repelled water-based

stains. Using Ag NPs along with PDMS on fabrics led to the development of simultaneous superhydrophobicity and antibacterial activity where the ratio of Ag NPs and PDMS played a key role in determining the extent of antibacterial efficiency against E. coli and superhydrophobicity of the fabrics. At the end, it was found that NM/PDMS coatings on cotton resulted in the development of fabrics with excellent superhydrophobicity and photothermal effect which could be used in developing protective clothing with localised thermoregulation functionality. It was confirmed that the NM/PDMS ratio directly impacted other aspects of fabrics such as durability of NM particles, the colour strength, and UV protection. The superhydrophobicity of all tested fabrics was > 165◦ which was excellent for fluorine-free coated cotton fabrics. Analysis of fabrics indicated that they still were breathable, flexible and with high durability against numerous wash and abrasion cycles.

Novel Knit-Structure with adjustable tensile behaviour based on combined Warp and WeftKnit technology

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Abstract

Knitted fabrics, especially weft-knitted fabrics, are used in many manufacturing industries. The stretch behaviour, the geometric diversity and the materials to be used are essential structural parameters that are also economically important. Currently, the very limited adjustable lengthwise elasticity of weft-knitted fabrics causes a reduction in fit, long-term stability and makes the dressing more difficult. To improve this behaviour, the new approach is to integrate warp-stitch threads into a weft-knitted fabric using conventional weft-knitting machine technology, thus significantly increasing the range of binding possibilities for the specific adjustment of lengthwise elasticity. The characteristics that can be achieved in this way open up new areas of application, for example in compression textiles.

SIMULATION OF FABRIC PERMEABILITY AND INERTIAL COEFFICIENT IN A SUPERCRITICAL CARBON DIOXIDE BEAM DYEING PROCESS

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Abstract

Dye liquor distribution plays a crucial role in beam dyeing as it affects the quality of dyed fabric in terms of evenness and hue. In the case of supercritical CO2 dyeing, the flow field in the fibrous material is dominated by the inertial loss since viscous loss is negligible due to low CO2 viscosity. This suggests that the Darcy law commonly used to describe the fluid flow in beam dyeing is not appropriate. In this work, a numerical approach to quantify permeability of the fabric during beam dyeing is presented and the estimation of the flow inertial coefficient is performed to accurately predict the fluid flow in a supercritical CO2 dyeing plant.

SILICA-CONTAINING PHOSPHORUS-BASED SOL-GEL FINISHING TO IMPROVE FLAME RETARDANT PERFORMANCE OF COTTON FABRICS

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Abstract

In this paper, the sol-gel technique was used to design hybrid phosphorus-doped silica structures for improving the thermal stability and flame retardancy of cotton fabrics. To this aim, diethylphosphatoethyltriethoxysilane (DPTS) was employed as phosphate alkoxysilane in a multistep procedure that involved multiple layers (from 1 to 6) depositions. The multi-layer coatings were applied by padding using sols containing appropriate molar ratios of the precursor, anhydrous ethanol, catalyst, and hydrochloric acid. Moreover, the synergism P-N on flame retardancy of cotton was assessed by introducing 3-aminopropyltriethoxysilane (APTES) as an N-donor precursor in DPTS sols. The effects of the catalyst during the alkoxide reaction and the silica amount applied by sol-gel treatment on the thermo-oxidative behavior of the treated fabrics, as well as the contribution of the obtained hybrid architectures on the final properties of treated fibres, were deeply studied. The creation of the silica skeleton on the cotton surface and the interactions between the cellulosic fibres and the doped layer have both been examined using FT-IR ATR spectroscopy. Moreover, thermal and thermo-oxidative stability, flammability properties, and combustion behavior of the sol-gel treated cotton fabrics have also been studied, proving the effectiveness of the sol-gel coating in the fire protection of the cellulosic substrate.

Parameter study on modified polyacrylonitrile based precursor fiber for carbon fiber production

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Abstract

E-mobility systems require the provision of efficient, light and durable battery solutions. However, current state-of-the-art batteries add a significant amount of weight reducing the potential panel of applications. Novel solutions for efficient energy storage that address the combination of supercapacitors (SC) performance and structural capabilities, reducing the weight as function of the energy stored, could be a major potential breakthrough in the field. Within the project PRINTCAP, the focus is on additive manufacturing to produce structural SC, a technology where the SSC will be geometrically designed and placed close to the shape of the final product in a close to zero-waste process. The material and process concept of the project is to use continuous porous carbon fibres not only for mechanical reinforcement but also as current collector and electrode material for energy storage.

Therefore, different additives are used to modify carbon fibers starting with the precursor. Followed by carbon fiber development and 3D printing for SSC. The porosity and the electrical conductivity of the carbon fibres (CF) then has to be tailored as the function of the use cases and to the specifications. The talk will consider different additives such as nanocellulose, graphen or hexabenzocoronene for the production of tailored polyacrylonitrile based precursor fibers.

Analysis of the influence of fiber orientations in carbon fiber-reinforced composites on their structural properties based on eddy current measurements

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Abstract

Fiber-reinforced plastics (FRP) are a type of composite material consisting of a reinforcing structure and a plastic matrix. When compared to traditional construction materials, FRP has higher strength and stiffness due to the high mechanical properties of reinforcing fibers such as carbon or glass. However, the properties of FRP are dependent on the alignment of fibers within the composite, with deviations leading to reduced strength and stiffness. Eddy current

testing is a non-destructive technique used to visualize carbon fibers in the composite and assess the impact of local fiber orientation on the structural properties of FRP. This study aims to understand the influence of local fiber orientation on tensile strength and elastic modulus by producing composites with defined fiber orientations, analyzing them with eddy current testing, and assessing their mechanical properties through tensile tests. The measured fiber orientations are then used to validate a finite element model, in which the actual, measured fiber orientation is applied to the simulation and correlated with the mechanical properties. In contrast to previous published studies measured fiber orientation is used, which as shown in this work, differs from the theoretically implemented fiber orientation.

New Approaches to 3D NCF Manufacturing

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Abstract

Textile reinforcements have outstanding load-bearing capabilities due to the excellent tensile properties of high performance multifilament yarns (e.g. carbon fibers). However, in order to take full advantage of their high potential, it is necessary to ensure that the filaments run in a straight line. In order to guarantee this straight filament course, the highly efficient multiaxial warp knitting process is used for the production of 2D non-crimp fabrics (NCF) as textile preforms. In various industrial applications, most structures have complex 3D geometries. Therefore, the 2D textile needs to be shaped for reinforcement, which often results in a rearrangement of the filament orientation. Consequently, the 3D shaping process has to be taken into account during the textile production or in the shaping process itself in order to guarantee the highest mechanical properties. New manufacturing approaches have been investigated to produce 3D NCFs suitable for load-resisting reinforcement of 3D structures. This can be achieved by a new textile approach to the production of near-net-shape preforms, which takes into account the rearrangement of the filaments during the forming process in combination with a newly developed gentle shaping process. Using the example of lattice girders for concrete reinforcement, a new approach for the fabrication of 3D textile lattice girders is presented.

Micromechanical modelling of the deformation mechanisms of friction-spun yarn from recycled carbon fibres

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Abstract

The growing use of carbon fibre-reinforced polymers (CFRP) results in an increased amount of CF waste from offcuts or end-of-life components. A promising method to reuse the waste fibre materials in a structural component with excellent mechanical properties is the processing of recycled CF (rCF) and thermoplastic fibres into hybrid yarns. Spinning of friction spun yarns consisting of more than 90% rCF and containing almost no thermoplastic fibres that are suitable for thermoset composites, currently leads to high fibre damage and low yarn quality and is therefore addressed in this project. The technology is reported in another paper. One of the limiting factors for drapability of textiles is the stretchability of continuous fibres and draping of the semi-finished textile products for complex geometries is still error-prone. Friction spun yarns exhibit significantly higher yarn elongations due to sliding mechanisms between the fibres. The deformation properties of friction spun yarns are significantly influenced by fibre-fibre interactions and depend on a variety of process and material parameters. In the following, micromechanical finite element models of the spun yarns are created by using beam elements. Monte Carlo method

is used to model local variabilities in the yarns. The models are then used to simulate yarn behaviour under deformation and to investigate the influence of various process parameters.

MECHANICAL PROPERTIES OF DIFFERENT YARN STRUCTURES BASED ON RECYCLED CARBON FIBRE FOR SUSTAINABLE THERMOSET COMPOSITES

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Abstract

The development of different hybrid yarn structures from recycled carbon fibre (rCF) (rCF content approx. 50% by weight) and thermoplastic fibres for thermoplastic composites have been reported earlier. However, manufacturing of yarns with high rCF content (>90%) required for thermoset composites is still not realizable due to high shortening (≥ 70%) in fibre length of rCF, which occurs during different processing steps of spinning. The reason lies in low shear strength, smooth fibre surface, small diameter and high brittleness of rCF. In addition to this, lack of crimp in rCF leads to drafting error during drawing and spinning process. Therefore, there is a high demand on rCF yarns for thermoset composites, as around 70% of composites are produced based on thermoset matrix. In this paper, yarns consisting of staple rCF with high rCF content (>90 weight%) are developed on DREF-friction spinning and wrap spinning technologies. For the production of yarns, slivers with different rCF content are produced using carding and drawing machine. The effect of different spinning parameters suction air pressure for DREF friction spun yarns and yarn twist for wrap spun yarns is investigated and their effect on tensile properties of yarn is analysed. The results show that the tensile properties of yarns can be adjusted to a wide range varying the yarn structure, spinning parameters and rCF content. Because of high rCF content in the yarns, they are suitable for a sustainable solution of the reuse of rCF in thermoset composites.

Effect of different machining processes on the bearing strength of pin-loaded textile composite panels for automotive: Experimental and FEM analysis

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Abstract

This research examines the influence of various machinability processes, including drilling, abrasive water jet machining, and laser beam machining along with various fibre architectures on the behavior of machined holes, bearing strength, and failure mechanisms of various textile structural composites produced from different textile structures such as chopped fibre, unidirectional (UD), bidirectional (2D), and three-dimensional (3D) orthogonal woven structures using glass, basalt, and sisal fibres suitable for automotive applications. Optical microscopic examination was used to evaluate morphological damage and fractography of the produced composite materials. In comparison to glass fibre reinforced textile structural composites and sisal fibre reinforced textile structural composites, experimental findings showed that basalt fibre reinforced textile structural composite specimens had the highest bearing strength for all processes. The bearing strength of composites was in the order of 3D > chopped > 2D > UD, respectively. In addition, a novel systematic mechanics-based approach was developed using SOLIDWORKS to create a mesoscale finite element model to analyse the bearing strength of pin-loaded textile structural composites. The woven-based composite material damage modes were predicted using the well-known 3D Hashin's failure and Puck's failure models, which were implemented via a user subroutine in conjunction with LS-DYNA. The bearing response predicted by the FEM simulation was found in a good agreement with the experimental findings.

Disruptions and Adaptations: COVID-19's Impact on Textile Supply Chain Management

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Abstract

The COVID-19 pandemic has significantly impacted the textile industry's supply chain management leading to unprecedented disruptions in global trade and manufacturing operations. This abstract presents an overview of the challenges faced by the textile industry during the pandemic and how supply chain management strategies are being restructured to mitigate risks and ensure business continuity. The pandemic highlighted the need for greater visibility and transparency in supply chains as well as the importance of diversification of suppliers and production facilities. Many new challenges in data quality were also exposed. This paper discusses the implications of these changes for the future of the textile industry and new thinking needed in managing supply chains.

Fabrication of Antimicrobial Cotton Gauzes Immobilized with Alginate/ Glycerol/ Tannic Acid Blend

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Abstract

Microbial invasion at the site of injury is the major challenge which hampers the normal healing process and exert high economic burden on the public health. Thus, bioengineers are directing their efforts towards the fabrication of antimicrobial wound management materials with infection resistant property, biocompatibility, and high exudate absorption. Biopolymers more precisely polysaccharides are emerging as alternative material with multifunctional properties such as biocompatibility and biodegradability. Sodium Alginate (SA) is an anionic biopolymer having features like high absorption capacity, biocompatibility, and rapid wound healing properties which makes it suitable for different biomedical applications. In the present study, SA based blend membranes were prepared with varying concentrations of glycerol and optimized with different physicochemical characterizations such as contact angle measurement, XRD, and mechanical analysis. Mechanical analysis indicated the increase in the flexibility of the membranes with increase in glycerol concentration due to the plasticization effect of glycerol. Further, different concentrations of tannic acid (TA) were added in to the optimized blend of SA:Gly followed by their coating on the cotton fabric by dip coating method. Antimicrobial potential of the fabricated dressings was studied with the help of colony count method and microbial adhesion analysis which indicated more than 95% viable colony reduction. Here, it can be concluded that such formulations hold great potential in the field of biomedical applications.

Bio-mercerisation of cotton to improve look, handle and dyeing properties of cotton

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Abstract

This presentation will discuss the treatment of cotton with an amino acid glycine to improve, brightness, dyeability, moisture and handle of cotton textiles. Mercerization is a century old process to enhance lustre, strength and dyeability of cotton. However, it requires highly concentrated corrosive alkali treatment as well as specialised equipment. In this presentation we will discuss an alternative treatment of cotton offering advantages similar to mercerisation using aqueous glycine without needing any special equipment. The treatment can alter look, handle,

tensile and dyeing properties of cotton. The process is used both in acidic and alkaline pH taking advantage of the amphoteric nature of glycine. Treatment at alkaline pH increases width, cross-sectional area and moisture regain while the treatment is also effective at acidic pH to improve cotton properties without adversely impacting on tensile properties. Fourier Transform Infrared spectroscopy (FTIR) and 13C solid-state nuclear magnetic resonance (NMR) demonstrated no appreciable change in crystallinity. However, there were changes in the chemical structure of cotton. The glycine treatment can be effective on fibre, yarn and fabric forms.

Continuous Mercerisation of Loose-Stock Cotton

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Abstract

Continuous Mercerisation of Loose-Stock Cotton

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Abstract:

Mercerising cotton has traditionally been processed as hanks of yarn, or as open-width fabrics, but commercial methods to mercerise loose-stock directly after ginning have had limited success. Arnold and Rippon (2003), (2010) produced continuous lengths of sliver that were fully mercerised without shrinkage, with increased fibre strength, enhanced dye-uptake, and improved surface lustre. Not only did the method prevent fibre shrinkage, but fibres could be stretched by as much as 4% and stably set. The disadvantage of this method was that it first required fibre to be fully processed to sliver form.

An improved prototype machine (Arnold, Padhye and Jadhav 2018) has now been successfully developed to mercerise ginned loose stock. Testing has confirmed that the output fibres are fully mercerised along their lengths, with increased tenacity compared with the Un-Mercerised Control. Fibre length has generally been maintained when compared with the Un-Mercerised Control, indicating that shrinkage normally caused by the process has been prevented. The dyeability of the fibre is comparable to that of a Slack-Mercerised Control. The improved lustre expected for mercerised fibre from this machine has not yet been confirmed. The production rate of the process can be readily improved, and the prototype expanded in size to increase output.

Key Words: Cotton, mercerising, loose-stock, sodium hydroxide, continuous processing

USE OF ROSA CANINA EXTRACTIONS IN TEXTILE FINISHING

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Abstract

Phenolic components, flavonoids, tannins and vitamins (A, C, E) in the content of Rosa Canina (R.C.) fruits provide antimicrobial and antioxidant activity and they already have many uses such as food and medicine industry. Despite the fact that R.C. extracts contain many beneficial and active components, they have not yet been studied as a finishing agent for textiles. In this study, it has been aimed to investigate the possible use of R.C. extractions as a

natural functional agent for fabrics. Initially, Rosa Canina extractions (50 g/L) were prepared using different solvents (distilled water, ethanol and methanol) by ultrasound-assisted extraction at 60°C for 60 min. Moreover, pre-treatment process with chitosan was carried out via pad-dry-cure method using cotton fabrics. Then, these extractions were applied to untreated and pre-treated cotton fabrics via exhaustion method. Obtained extractions and waste solutions of textile finishing process were examined by Ultraviolet–visible (UV-Vis) spectroscopy for chemical analysis. In addition, the chemical structure of the untreated and treated fabrics was characterized by Fourier-transform infrared spectroscopy (FTIR). Finally, treated fabrics were examined in terms of UV protection properties by UPF measurements. UV-Vis results showed that maximum amount of active compounds were observed on R.C. extraction with water. According to UPF values, pre-treatment with chitosan definitely have a positive effect on UV protection of cotton fabrics and R.C. extract treatments lead also an extra increase on UPF values of cotton fabrics. Among all treated fabrics in the study, chitosan-R.C. water treated fabrics showed the highest UPF value.

DYEING NATURAL FIBERS WITH SAPPANWOOD

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Abstract

This research investigated the dyeing properties of a natural dye obtained from sappanwood (Caesalpinia sappan) on wool and cotton fabrics. The dyestuff from sappanwood is brazilin (C.I. 75280). Brazilin is a homisoflavanone with weak coloring power. On oxidation, brazilin changes to brazilein, which yields a deep red dye. The effects of different mordants on color were studied with the goal to compare the performance of the dyestuff on each combination of substrate + mordant. In addition, solvent, and aqueous extraction of the sappanwood were used to compare the color from different extraction mediums and methods. Colorfastness to light, colorfastness to washing, and colorfastness to perspiration tests were performed on dyed samples to gauge the color fastness performance of sappanwood dye. Samples of wool dyed with ethanol sappanwood extract displayed pink color tones. Samples mordanted with symplocos, a natural plant-based mordant exhibited the most intense color followed by alum-mordanted samples and the gallnut-mordanted samples had the least concentrated color. Cotton samples dyed with ethanol sappanwood extract were more consistent in their color properties. Wool samples dyed with aqueous sappanwood extract exhibited varied tones of red depending on the mordant. Samples mordanted with symplocos showed a rich, true red color while the alum-mordanted samples had a muted tone of red and the samples mordanted with gallnut revealed an orange color. In line with ethanol extracted dyed samples, cotton fabrics dyed with aqueous sappanwood extract displayed a consistent color regardless of the type of mordant.

BIODEGRADATION OF SHEEP WOOL INTENDED FOR PLANT FERTILIZATION

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Abstract

Coarse wool obtained from Polish mountain sheep is difficult to spin and process with traditional textile techniques. One of the possible rational utilization of this type of wool involves application as an organic fertilizer in agriculture and horticulture. In this case, the wool which is buried in the soil undergoes biodegradation during which wool keratin is decomposed into shorter peptides and particular amino acids. The nitrogen-rich organic compounds released during biodegradation are gradually transformed in the soil into mineral nitrogen forms which serve as nutrients promoting plant growth. Biodegradation is influenced by environmental conditions and depends on the degree of wool damage. To investigate the impact of wool treatment and environmental factors on wool biodegradation, studies in field conditions were performed. Unwashed waste wool selected right after sheep shearing, wool chopped into short segments and wool pellets were applied as fertilizers. These different forms of

fertilizers were mixed with peat and arable soil to prepare several experimental plots. Then for one year, the wool samples were periodically taken, cleaned and analysed using Scanning Electron Microscopy (SEM), Energy-dispersive X-ray Spectroscopy (EDS) and Fourier Transformed Infrared Spectroscopy (FTIR). During the examinations, changes in the fibre morphology and chemical structure were observed. Based on the laboratory tests, the wool biodegradation by fertilizer form and soil type was analysed.

ECOLOGICAL APPROACHES IN YARN DYEING

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Abstract

In today's globalizing world, the rapid depletion of natural resources, increasing air and water pollution, deforestation, and climate change are significant environmental problems for industrial activities. Many industrial activities contribute to environmental pollution as the cause of these problems. Therefore, developing environmentally friendly production methods, reducing resource consumption, and minimizing environmental impacts are of great importance.

The yarn dyeing industry is a sector where natural resources are intensively used and environmental pollution problems are seen. Innovations in this sector aim to make production methods more sustainable. In particular, the process reduction method is an important step in reducing resource consumption and minimizing environmental impacts. In this way, an important opportunity is provided for the preservation of natural resources and the production of environmentally friendly products. Therefore, with the increasing demand for ecological products, the development of an environmentally friendly, sustainable, and nature-friendly process in yarn dyeing is targeted.

The new process developed within the scope of the project is gaining importance in the textile sector due to the limited availability of natural resources and increasing environmental problems. The aim of the project is to eliminate the bleaching step used in traditional yarn dyeing processes, reduce the use of water, energy, and chemicals, and create an environmentally friendly product platform. In this way, with the increasing demand for ecological and sustainable products, customer expectations can be met, and the company's environmental impacts can be reduced.

Retaining Colour in Regenerated Cellulose Fibres from Waste Textiles

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Abstract

Textile recycling and sustainability have become topics of major interest, at the forefront is creating circular approaches for textiles. A current approach for recycling cotton and cellulosic-based textile fibres is using an ionic liquid solvent to dissolve the waste textiles. A regenerated cellulose fibre (RCF) can then be created using either wet or air-gap spinning. The RCF produced from waste textiles share many similar properties to current commercial viscose or lyocell fibres. This technology has been demonstrated for many different ionic liquid solvents. A hurdle remains in the colour of the waste textile and when the textile is a blend of cotton and a synthetic fibre such as polyester.

Colouring a textile fibre is both chemically and energy intensive and the process is considered to be the most polluting component of textile production. Here we show an approach whereby the colour of the original waste textiles can be retained in the recycled RCF. We apply the technology to recycle 100% cotton waste textiles and

evaluate the properties of the resultant RCF. The viability of the technology for producing new textiles was demonstrated by producing a coloured scarf which required no additional wet processing or dyeing. The recycling technology was also applied to separate cotton -polyester blends, showing that the original colour can be retained in both the RCF and polyester after separation.

DETERMINATION OF THE DEGREE OF FIBER MIXING IN HYBRID YARNS AND COMPOSITES BASED ON NEURAL NETWORKS

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Abstract

A deep understanding on the intermixing of components in hybrid yarn or composite structures is decisive in order to develop hybrid structures with desired properties. This paper presents the development of a versatile procedure for the determination of the degree of fiber mixing in yarns and composites based on microscopy images auto-segmented by a neural network. The procedure is based on the quantification of blend irregularity values and blend homogeneity. For this purpose, functions of spatial point patterns analysis have been used to investigate the blend uniformity of yarn and composite cross sectional areas. The results show that the trained neural network model for segmentation of images has an accuracy of 92 %, indicating that the method is capable of accurately assessing the location of fibers in hybrid structures. The results of the spatial point patterns analysis reveals a correlation between the blend value and the properties of yarns and composites. The proposed method provides a fast and reliable way to evaluate the hybrid structures, which could be used as a tool for quality control and process optimization.

INVESTIGATION OF ABRASIVE PRE-TREATMENT TO MITIGATE LENGTH LOSS DURING MECHANICAL TEXTILE RECYCLING

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Abstract

The environmental burden of the textile industry can be decreased with an increased use of mechanically recycled fibers. However, it is well known that the recycling process is harsh and shortens the fibers substantially. Still, little has been investigated about the influencing factors of the fiber length loss.

The work at hand investigated this theory by subjecting woven cotton textiles with abrasion treatment prior to mechanical recycling. We compared two different methods of abrasion with unabraded textile. The two pre-treatment abrasion methods used were rubbing with sandpaper and raising with steel pins. By measuring the fiber length post mechanical recycling, we could estimate the efficiency of the recycling process in respect to preservation of the fiber.

Results showed that only the raising process had a positive impact in mitigating fiber length loss through the recycling process. During the rubbing with sandpaper, the fabric was pressed down and thus became denser. On the contrary, the raising process pulled out the fibers and created a fuzzy surface. As the removal of any fiber affect all fibers in direct contact, even fibers in the center of the yarn are affected when surface fibers are pulled out or weakened. The raising process extracted fibers which opened up the fabric and affected the yarn structure. Hence, the yarns were more easily disentangled in the recycling process. The result gives great insight into the mechanisms of mechanical recycling and can be used for future development of the same.

INFLUENCE OF LACCASE ENZYME ON THE BIODEGRADABILITY OF INDIGO BLUE DYED FABRICS.

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Abstract

Improving the environmental impact of textile waste is essential for the good functioning of the planet, as it is not viable to prolong the recycling of textile materials indefinitely due to the loss of properties. The presence of dyes in fabrics is a key point to study from the perspective of biodegradability, as the presence of these dyes in effluents is widely studied due to their high polluting impact on water.

This project has analysed whether the presence of dyes in fabrics affects their biodegradability process. In addition, it has been studied whether finishing with laccase enzyme, which is usually used to purify the wastewater from the dyes of the indigo blue dye used, influences the degradation of the fabric. For this purpose, dyed and undyed cotton fabrics impregnated with this enzyme were analysed.

Following the proposed measurement protocol, it has been defined that fabrics dyed with the indigo blue dye (VAT BLUE I) have a positive influence on degradation, while the presence of small doses of compounds added to the fibres, such as the laccase enzyme studied in this case, can lead to the generation of deviations in the biodegradability of the sample. Although the efficiency and efficacy of this enzyme in dye degradation under anaerobic conditions has been demonstrated, under compost conditions its effectiveness decreases and negatively influences the biodegradability process. No ecotoxicity is shown in soil after the biodegradation process.

Development of Fashion Design through Textile-based 3D Printing

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Abstract

Three-dimensional (3D) printing on textile substrates is regarded as one of the most efficient methods to bond rigid polymers and soft fabrics to impart novel 3D surface effects and extend applications of wearable materials. It has gained popularity due to its direct manufacturing process and digital computer aided-design tools. Many designers have explored textile-based 3D printing technique to create fashion design and developed customized products. However, it is observed that most 3D printed creations are at conception stage. The physical and mechanical properties of the textile-based 3D printed designs still need to further study. This study applied polylactic acid (PLA) and resin materials on an organza polyester fabric towards innovative 3D printing fashion designs. The main wearable performances of the printed materials on the polyester fabric under a microscope, along with tensile, tear, and joint motion tests were evaluated. The printed samples with patterns remain good adhesion, breaking, deformation, and bending effects when each design unit size is less 7 mm in length or diameter which have an enough space between each of units. A full-length dress, a skirt, and a skirt suit are produces by using the developed process. The fashion design inspirations and production method have been reported in detail. A comprehensive textile-based 3D printing fashion design process and manufacturing model are established. The research of the 3D printed fashion design show significant contribution theoretically and practically. Accordance with the developed method, various patterns can be applied to extend forms and connotations for modern fashion design.

THE DEVELOPMENT OF A BASE LAYER FOR A SENSORIMOTOR COUNTERMEASURE SKINSUIT: GARMENT COMFORT AND MOBILITY

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Abstract

When an astronaut transitions out of the weightless environment of space (e.g. landing on Earth, Mars or the Moon), they can experience balance and co-ordination issues. NASA has highlighted this as a health and safety risk associated with decreased sensorimotor function caused by time spent unloaded in microgravity and has requested greater mitigation for future long duration missions. Garment countermeasures have been developed to combat these health issues; however, it has been reported that these garments can be uncomfortable and restrict the wearer's mobility.

This paper details the development of the base layer garment for a Sensorimotor Countermeasure Skinsuit (SMCS), and test ideas to improve the comfort & mobility through considered patternmaking techniques.

A Version 1 (V1) SMCS base layer was made-to-measure for one participant. The garment was assessed for comfort and mobility through a series of tests (sit and reach, joint range of motion, etc.), which were compared to a baseline of loose gym clothing. The V1 SMCS caused a restriction to mobility, and scored low comfort ratings, when compared to the baseline.

A Version 2 (V2) SMCS base layer was developed with an objective of improving upon the comfort and mobility ratings. A V2 SMCS base layer garment was assessed and was found to have improved comfort and mobility ratings when compared to the V1 SMCS.

The results of this study can be used to advance the design of compression garments that are used within the sports and medical industries.

Money Talks, Fashion Walks: A Textile Motif Exploration in Womenswear using 1960s Rupiah Banknotes

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Abstract

This project-based research examined the explorations of the *Soekarno-Irian Barat* Rupiah banknotes' visual element as textile motifs, which were then produced into a womenswear collection using digital printing technique. The topic was chosen based on the phenomenon among society that often sees money only as a trading tool, while actually it bears more meanings for a nation, including historical, cultural and political messages, which makes it eligible to be also known as a cultural heritage product that deserves to be preserved. One alternative to preserve the visual elements of a cultural heritage product is through fashion product application. The project started with literature studies and interviews; explorations of motifs, designs, materials and also style studies; and completed with fabric and garment production.

THE AESTHETIC FACTORS SHAPING CHINESE MILLENNIAL CONSUMERS' PURCHASE INTENTIONS OF LUXURY PYJAMAS: IMPLICATIONS FOR FUTURE DESIGN

Yingmiao Wang, Carolina Rodriguez
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Abstract

The luxury fashion market is rapidly expanding worldwide, and the demand for designer pyjamas is growing. Pyjamas originated in South Asia as loose, lightweight trousers or two-piece suits for sleeping and lounging, and evolved into swishy palazzo-like pants and jumpsuit styles popular in Europe. Over time, pyjamas have undergone multiple functional and aesthetic changes while the luxury purchasing power of Chinese millennials who were born in a rapidly evolving digital world has increased fast. However, limited academic research on luxury pyjamas and scarce information on this specific consumer group are available. This study examines the main aesthetic factors that influence Chinese millennial consumers' purchase intention of luxury pyjamas and specifically evaluates the importance of design elements such as artistry, colour, texture, fit, silhouette, innovation, and craftsmanship. A survey was conducted with 124 Chinese participants via the Chinese social media platform WeChat to determine their aesthetic preferences for luxury pyjamas. The findings reveal Chinese millennial consumers regard pyjamas as functional items and mainly wear them at home. Aesthetic considerations are the main purchase driver of sleepwear, with the visual texture of pyjamas as the most important aesthetic factor for Chinese millennial consumers, emphasizing the need for product developers to choose exquisite and appealing fabrics. Colour and artistic elements, such as colour collocation and pattern print, also have a significant impact on their purchase intention. This study provides valuable insights for luxury sleepwear developers seeking to enhance the aesthetic design aspects of their products to meet Chinese millennial luxury consumers' needs.

UNDERSTANDING THE MARKETING STRATEGIES USED BY CHINESE FASHION MICRO-INFLUENCERS TO IMPROVE CLICK-THROUGH RATES

Peirong Ye, Carolina Quintero Rodriguez
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Abstract

Influencer marketing is an effective marketing strategy that significantly influences the purchase behaviour of social media users. Social media influencers are the core of influencer marketing and are considered as ‘experts’ in one or several topics. Accordingly, fashion influencers are individuals with a high volume of followers on social media platforms who share information on related fashion topics. Micro-influencers have shown more authenticity and credibility than mega-influencers, creating an opportunity to develop more personal and relatable marketing materials on their platforms. Although research is available on the marketing strategies used by micro-influencers to increase their audience reach, scarce research on Chinese micro-influencers is available. This research aims to investigate the communication strategies used by Chinese fashion micro-influencers to improve their influencer value on the Chinese social media platform XiaohongShu. This study used a case study methodology and interviewed five in-depth Chinese fashion micro-influencers to understand the communication strategies used to increase their marketing performance. The inductive thematic analysis determined the main strategies for creating fashion information posts aligned with their personal styles. While the findings showed that fashion micro-influencers had their individual communication style, it was also revealed that keeping a post short and clear was the most effective approach when developing a post. The use of catchy titles was determined as a strategy to increase click-through rates. This study contributes to the understanding of the strategies used by micro-influencers to develop marketing materials on the Chinese social media platform, XiaoshongShu.

THE INTERSECTION OF FASHION AND CLIMATE: A COMPARATIVE EXAMINATION OF THE AUSTRALIAN FASHION AND TEXTILE INDUSTRY'S APPROACH TO CLIMATE CHANGE

Aayushi Badhwar, Saniyat Islam, Caroline Swee Lin Tan
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Abstract

This paper delves into a comparative review of the actions of the Australian fashion industry in response to climate change. The focus of this review centres around major benchmark events in the Australian landscape of policies and regulations enactment, which shape the consumption of fashion in the country. This paper compares the interconnectedness or disconnected discourse of the fashion and textile industry's trends, in response to climate change, within the Australian context. Climate change is set to catastrophically impact global food supplies and endanger human health by inducing heat-related mortality, cardiovascular diseases and mental health issues. In the next decade, it is expected to force millions of people into extreme poverty. The severity of climate change awareness has transpired the sustainability concept into a prime prerequisite for global business models. Fashion and textile businesses are quickly adapting to lower their environmental impact. However, this industry is still considered to be the second-most polluting sector globally. It contributes to green-house gas emissions via raw material extraction, production, and distribution processes. In addition, synthetic textiles impact the marine biosphere by releasing microplastic fragments. At the end of the product life cycle, most textiles are discarded in irreversible landfills. Australia is the second biggest consumer of textile, clothing and footwear products. Therefore, it is critical to compare the impact of the Australian fashion and textile industry and its response to the climate crisis.

TREATMENT AND CHARACTERIZATION OF COSMETOTEXTILES WITH ANTIBACTERIAL ACTIVITY

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Abstract

The textile industry has recently developed innovative products that integrate functional properties into consumer textiles. Textile materials with specific applications in the cosmetic field are a special class that is developing rapidly [1,2]. This study focuses on the physicomechanical characterization of polyester textiles treated with two different dispersions and the process of functionalization of the textiles. The dispersions used are a combination of lyophilized plant extracts (propolis, aloe vera, calendula, plantain) and blue clay. The difference between these two dispersions is that nano-halloysite was also added to the second dispersion to get a better picture of the effect of the blue clay.

The physical-mechanical properties of the cosmetotextiles that allow the user to wear them comfortably and provide the desired benefits were evaluated using some analyses. The contact angle was measured, based on which the ability of the textile to repel liquids can be determined, even after treatment.

Resistance to acid and alkaline perspiration was determined, and spectra obtained with a SEM in conjunction with an EDS showed that the applied finishing treatment withstood 20 wash cycles.

The last analysis performed was for water permeability, with increased values of this parameter found for some of the treated samples compared to the values of the starting material.

Ultimately, this article is part of a larger study aimed at developing new functionalized textiles with increased antimicrobial activity and improved efficiency in curing some types of acne. Therefore, further tests will be conducted regarding the antimicrobial activity of the treated textiles.

PERFORMANCE PROPERTIES OF SWIMWEAR FABRICS PRODUCED FROM POLYESTER AND RECYCLED POLYESTER FIBER

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Abstract

The textile industry is responsible for producing a significant amount of global CO2 emission, which is the biggest contributor to global warming and climate change. Researchers have focused on reducing greenhouse gas emission by recycling textile materials rather than producing new fibers through circular economy approaches. Using recycled fibers or blending them with recycled fibers is becoming an essential approach to strike a balance between textile quality and sustainability. In this study, swimwear fabrics made of 100% polyester, and 50% polyester-50% recycled polyester fiber were investigated in terms of their performance properties including color fastness, abrasion resistance, and seam strength. This study will provide a better understanding of the effect of the polyester fiber and recycled polyester fiber combination on the performance/quality properties of swimwear fabrics.

Exploring Internet of Things in Higher Education: Students' Perceptions of Cognitive Benefits and Immersive Learning Experiences

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Abstract

The twenty-first century is a century in which everything is interrelated by human activities and technological advancements. As one of the most widely used software programs, the Internet of Things (IoT) has amassed a stunning user base that totals over 5.16 billion individuals, which is equivalent to around 64.4% of the population of the whole world. The purpose of the research is to provide insights into the usefulness and efficiency of IoT deployment in the teaching and learning process. This will be accomplished by evaluating how students interact with IoT and how they perceive its advantages and challenges. T In addition, the research is intended to gather data using three different methods known as triangulation. These methods include observation, participation in a focus group discussion, and an online survey. The findings indicate that students perceive numerous immersive and personalized learning experiences, inclusively and accessibility, collaboration, and engagement in the classroom. This fosters dynamic and enriched technological learning within the context of the university, as well as the capability to address various aspects of the educational process, such as the delivery of content. As stated by Respondent A2, "Satisfied enough, because with the existence of IoT, it has provided many benefits for me as an IoT user, especially with all the devices connected to the internet, users can control and monitor those devices." Students benefit from an improved research experience and overall learning environment because to this simplified method, which gives them easy access to a multitude of information and tools.

Development of Electrospun Bioactive Polycaprolactone/ T. arjuna Nanofiber for Biomedical Applications

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Abstract

Biodegradability and biocompatibility of Polycaprolactone (PCL) nanofiber makes it suitable for various biomedical applications. The challenge of using PCL is its hydrophobic nature, which restricts its blending with hydrophilic drugs. The novelty of this work is the modification of PCL in a single-step approach using a co-spinning agent, surfactant. The addition of surfactant reduces the mean fiber diameter of electrospun PCL nanofiber. Simultaneously, it

enhances wettability by making it superhydrophilic. It resulted in the successful addition of hydroalcoholic extract of T. arjuna, providing antioxidant and antimicrobial properties to nanofiber.

In this study, the morphology and wettability of polycaprolactone (PCL) nanofiber was ameliorated by the addition of two surfactants: Bis (2-ethylhexyl) sulfosuccinate (AOT) and TritonX-100 (TX 100). Surfactant concentrations were optimised to obtain bead-less nanofiber. The physicochemical properties of the developed nanofiber's morphological study were characterised using SEM, AFM, XRD, EDX mapping, and contact angle. The optimised surfactant was used to incorporate T. arjuna in PCL nanofiber. Further, its antioxidant property and antibacterial activity were investigated.

The addition of surfactant has reduced the mean fiber diameter from 1.18± 0.112 µm to 235± 97 nm. Significant changes in its roughness, crystallinity and wettability were also observed. Among the two surfactants studied, the anionic surfactant AOT, was used for T. arjuna addition. The PCL/ T. arjuna nanofiber shows more than 92% antioxidant activity and 99.93% antibacterial activity. Also, TEM images show the impact of the extract on the bacteria morphology. The bioactive PCL/ T. arjuna nanofiber shows good potential for biomedical applications.

Designing of Antimicrobial Polyurethane Catheter for Prevention of Infections

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Abstract

The implant of polymeric invasive medical devices represents one of the most important nosocomial infection risks. Catheter-associated urinary tract infections (CAUTIs) are the leading cause of nosocomial infections that accounts for up to 40%. Due to its high strength and inert properties, polyurethane (PU) has found enormous interest in medical devices. The biofilm accumulation on the surface of polyurethane is the biggest hindrance to its usage as a safe and prolonged catheter. To overcome this issue, we have used carboxymethyl cellulose (CMC) as functional coating material.

The polyurethane was functionalized via aminolysis using diamines to generate hydrophilic (amine and hydroxyl) functionality on the polyurethane surface. The OCMC was coated on functionalized PU with a Schiff-base reaction. Nitrofurantoin and silver nanogel were used as bioactive agents to impart antimicrobial properties to the OCMC coating of PU catheter. Core-sheath silver nanogels were synthesized using an in-situ polymer reduction technique using OCMC. Thus, silver nanoparticles have covalently bonded OCMC polymer in sheath. Different blend ratios of drug and Ag nanogels were incorporated to analyze antimicrobial activity. The designed antimicrobial PU catheter was characterized using Contact angle, SEM, AFM and FTIR. The antimicrobial efficacy of the OCMC-Ag-Nitro PU catheter was studied using bacterial reduction and serial plate transfer technique against E. coli and S. aureus bacteria. The antimicrobial catheter showed ~99 % bacterial reduction and biocidal activity against both bacteria. Real-time implant crisis and biocompatibility of the designed catheter were studied using a histogram study of the subcutaneous implant of a catheter in Swiss mice.

Development Of A Composite Mesh With Dual-Sided Properties For Hernia Repair

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Abstract

There are side-specific requirements for implantable devices based on their location inside the human body. For instance, surgical meshes for hernia repair require anti-adhesive property on the visceral side and cell adhesive

property for quick healing on the parietal side. The porous structure of the mesh and the arbitrary shape of its pores make it challenging to impart different properties on each side without losing the natural porosity. This work explores different approaches to address this issue using various techniques and materials. Zwitterionic 2-methacryloyloxyethyl phosphorylcholine polymer (PMPC) and chitosan were applied on the visceral and parietal sides of a single mesh to impart protein anti-adsorption and cell attachment properties, respectively. This side-specific modification with these biopolymers is expected to ensure a minimum inflammatory reaction, anti-adhesion on the parietal side and antimicrobial properties with quick healing. Eight different techniques were used for side-specific modification. Attenuated Total Reflection–Fourier Transform Infrared spectra were performed on both sides of the modified meshes to confirm the presence of PMPC and chitosan on their respective sides. SEM images of the modified mesh with the optimized technique confirmed its porous structure. The aim of this work is to develop a suitable technique that can successfully modify each side of the mesh differently without compromising its porous structure and stability.

Influence of hydroxyapatite particle size on PHBV fibers for bone tissue engineering

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Abstract

Bone grafts are the second most transplanted tissue helping patients with damaged or diseased bone tissue. Current methods to replace skeletal defects are autografts (healthy bone tissue from the patient is relocated to the defect side) and allografts (bone tissues from a donor). The major drawbacks of these methods are the risk of disease transmission and limited supply. Tissue engineered scaffolds from biocompatible and biodegradable biopolymers like poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) and hydroxyapatite (HA) try to tackle that problem. While the bioactivity of HA is undisputed, there is still a debate about the most promising HA shape and size. This study investigates the effect of seven different HA particle sizes at three different concentrations on as-spun PHBV/HA fibers. The results of differential scanning calorimetry did not reveal any major changes regarding the melting temperature of the PHBV/HA blends compared to the neat PHBV while the degree of crystallinity was decreased when adding HA. Single fiber tensile testing showed a decrease in tensile strength after HA addition. Studies in simulated blood matrix demonstrated that the fibers with HA do not degrade faster than neat PHBV fibers in a period of three weeks. Results from a two-week mineralization study in simulated body fluid are still pending. Afterwards the most promising HA can be selected and further research on the improvement of the mechanical properties will be done to be able to melt-spin fibers that are suitable for textile-based bone tissue engineering.

Woven and knitted scaffolds for Tissue Engineering applications using a PCL-PLA nanofibrous core-sheath yarn

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Abstract

Textile technologies have received growing interest in the field of tissue engineering over the last decade to develop anisotropic, hierarchical structures that serve as temporary cell carriers. Precise control of fabric properties using different textile techniques offers great potential for clinically relevant and industry-transferable production methods. Textile patterns can be designed to control porosity, architecture, and mechanical properties that

ultimately influence cell responses and promote cell activities. Nanostructured textile scaffolds engineered from nanofibrous yarn provide a large surface area relative to volume. Since cells can recognise and respond to nanotopographical features of their substrate, nanofibrous fabric surface closely mimics the fibrous surface of human tissue, favouring cell attachment, proliferation and differentiation.

This cross-disciplinary project bridges biomaterial and textile engineering to demonstrate the potential of woven and knitted scaffolds. A novel electrospinning setup was used to develop a nanofibrous core-sheath yarn made of a polylactic acid (PLA) multifilament core and polycaprolactone (PCL) nanofibrous shell. Plain woven and single jersey weft-knitted scaffolds were fabricated from the PCL-PLA core-sheath yarn.

Scaffold microstructure and cell distribution were imaged using SEM. Relatively uniform and bead-free fibres with smooth surfaces were obtained. The plain woven structure exhibited greater surface density, whereas the knitted structure was more porous. Biocompatibility was evaluated and cell proliferation was determined by culturing NIH/3T3 and HUVECs on textile scaffolds by LIVE/DEAD assay.

The results show the potential of textile-based scaffolds as a versatile and scalable approach for TE. This study contributes to developing and designing textile-based scaffolds for soft tissue engineering.

What is the Potential of Circular Economy in the Fashion and Textile Industry of Bangladesh?

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Abstract

The fashion and textile industry in Bangladesh has experienced rapid growth over the years, making it a significant contributor to the country's economy. The concept of a circular economy presents a potential solution to address these challenges by promoting resource efficiency, waste reduction, and sustainable practices throughout the industry's value chain. This research investigates the potential of implementing a circular economy in the fashion and textile industry of Bangladesh. Through a thorough review of literature, survey, and interview with stakeholders from industry, retail, international brands, and recycle-related organizations, this study examines the current state of the industry in Bangladesh and explores the opportunities and barriers associated with adopting circular economy principles. Various aspects, such as product design, material sourcing, manufacturing processes, consumption patterns, and end-of-life strategies, are analyzed. The findings indicate that the textile industry in Bangladesh is predominantly linear, with fast fashion dominating the market. However, there is a growing awareness and willingness among stakeholders to transition towards circular practices. The research identifies potential benefits of embracing a circular economy, including reduced environmental impacts, improved resource efficiency, economic opportunities, and social development. Based on the analysis, recommendations are provided for stakeholders in the industry, emphasizing the need for education, investment in recycling infrastructure, collaboration, and sustainable consumption practices. This study highlights the potential of a circular economy in transforming the fashion and textile industry of Bangladesh, offering insights and actionable recommendations for policymakers, manufacturers, and consumers to create a more sustainable and resilient industry.

Wearing Waste

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Abstract

Through modern consumption patterns society discards an ever-increasing amount of material waste. Such behaviour is ultimately unsustainable, and the need to institute a more Circular Economy where recovery and regeneration of valuable materials from waste is becoming an ever-increasing priority. The textile industry, in particular, is a significant consumer of fresh water, pesticides and land. While up to 23 kg of textile waste a year are discarded to landfill by each person in Australia, of which cellulosic fibres is a significant contributor. In response to an-increasing requirement by industry, government, and society at large, for solutions to these challenges, The Institute of Frontier Materials (IFM) have instituted a new research priority around Circular Economy. To facilitate this demand, with the support of the Australian National Fabriciation Facility (ANFF), Deakin has expanded the facilities offered from fiber production to yarn and textile manufacture.

Here I will present a case study utilising the increased infrastructure in collaboration with and industry partner illustrating the expanded capabilities at IFM. Nanollose is a biotech start-up, whose aim is to manufacture sustainable textiles, replacing unsustainable wood pulp with regenerated bacterial cellulose produced via the fermentation of food waste. I will discuss the challenges, lessons learned and outcomes of entire process from wet spinning of their NullaborTM fibres, through to yarn spinning and textile construction of a knitted garment with industry partner Knovus, and finally to the launch of the Lee Mathews designed garment at the Copenhagen global fashion summit demonstrating Australian manufactured Circular Textiles.

A standard terminology for the description of fibrous microplastics from textiles

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Abstract

Microplastics, fragments of plastics from regular use, are causing severe environmental hazards and health dangers. They could be ingested by marine animals and further enter the human food chain. Research shows that the majority of the microplastics (35%) released in the environment are from textiles. Therefore, there is an increasing interest in the studies of microplastics released from textiles to control the pollution from their origin. To understand the microplastics released from textiles, the properties of microplastics are important. However, the definition of microplastics is still confusing as most of the studies consider microplastics to have a size of < 5 mm, as defined by Arthur (2009). But microplastics from textiles are mainly in the form of fibre, which is shape-dependant. In textiles, microfibre has its definition with diameters measuring < 10 µm. The difference between the two definitions produces confusion and makes it hard to compare results within the literature. Although some researchers proposed terms, such as 'fibrous microplastics', 'fibre fragments' or 'fibre shedding', there is no international consent on the fibre-shaped microplastics till now. This paper endeavours to unite the current terms used for microplastics or microfibre from textile inspection and provide a new definition of fibre-shaped microplastics to avoid further confusion.

Textile non-regenerated cellulose microfibres are pervasive, yet overlooked, potential pollutants in surface waters: a global study

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Abstract

The presence of microplastics in the ocean was first reported in 1972. It was only in the 2010s that they received greater attention. Textile microfibres, made of synthetic polymers, were listed early among microplastics. Artificial and natural fibres were overlooked since the 2020s, mostly due to a “natural” bias and harsh sample preparation protocols. It has recently been reported that the majority of anthropogenic objects found in oceanic surveys is composed of coloured natural cellulose fibres. This is in stark contrast with the annual reported volume percentages for synthetic, artificial and natural fibres. The reasons behind this discordance, and the distribution of natural cellulose textile fibres are unknown. A large global survey was conducted by the authors over 3 years, in partnership with The GLOBE Program, to shine a light on distribution, in a global effort to harness the power of school-performed environmental monitoring as a test bed for data generation and novel scientific protocols. The results of this large-scale survey confirm that natural (non-regenerated) cellulose textile fibres (especially dark, blue and red) were predominant in all types of surface waters, in all test locations, in some cases with concentrations of over 100,000 cellulose fibres per cubic meter. These results suggest that cellulose fibres do deserve bespoke attention in terms of understanding their biodegradability and impacts on the environment. This presentation will discuss the benefits of simplified, yet scientifically robust protocols, as well as their limitations, in rapidly investigating emerging pollutants and challenging established assumptions.

Australian Cotton and the Global Apparel Supply Chain: Sustainability Issues in Context

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Abstract

Cotton dominates the natural fibre market worldwide, as evidenced by its 24% market share. Australia is the world's fourth largest exporter, following the United States and India. The industry is significant for Australia, generating $2 billion dollars in exports per annum and employing approximately 10,000 people across the industry. However, sustainability concerns associated with cotton production, as well as evolving consumer awareness and an increase in sustainability initiatives and regulation, have brought sustainability to the forefront of the Australian cotton industry's agenda. The paper will provide a contextual review of the various sustainability aspects of cotton, such as genetically modified and non-genetically modified cotton, credible claims around environmental impacts, chain of custody and circularity approaches. This paper draws on publicly available information including industry reports, news articles, and certification websites. The paper provides valuable insights into the sustainability challenges for the Australian cotton industry, which can inform policymakers, industry stakeholders and consumers.

Poster Abstracts

Preparation of cellulose/graphene oxide films crosslinked by vinyltrimethoxysilane

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Abstract

In this study, we adopted a simple and environmentally friendly silane crosslinking method to crosslink cellulose and graphene oxide (GO) together. The cellulose/GO hybrid membrane were characterized by FTIR, SEM, surface resistance. Results show that the covalent bond between cellulose and GO was formed by vinyltrimethoxysilane (VTMS), and GO was successfully cross-linked on the surface of the cellulose membrane. In addition, it also exhibits extremely low surface resistivity (720.69 Ω). It shows great potential conductive membrane as electronic device.

ENHANCED SIDE-ILLUMINATION OF ETCHED POLYMER OPTICAL FIBER (POF)-INCORPORATED WOVEN POLYESTER (PET) FABRICS

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Abstract

The textile industry has been weaving polymer optical fibers (POFs) into plane fabric for many years for lighting and decoration. To apply POF-incorporated fabrics in a larger field of application, it is necessary to improve the side illumination of POF-incorporated fabrics. It has been reported that the chemical etching method is one method to enhance the illumination of POFs, while there is little research related to the application of chemical etching to enhance the illumination of POF-incorporated fabrics. In this work, the end emitting POFs (EEPOFs) were used as weft yarns, and polyethylene terephthalate (PET) yarns were used as warp yarns. The POF-incorporated woven PET fabrics were successfully fabricated with a 1/3 twill structure and then treated with a mixture of acetone and methanol (volume ratio: 1:1) for 1 min. The morphology and side illumination of etched POF-incorporated PET fabrics were investigated. As a result, the acetone/methanol mixture destroyed the cladding layer of EEPOFs, and the

luminance of etched POF-incorporated PET fabrics was increased by more than 50 %. Besides, acetone/methanol etching resulted in a higher side illumination attenuation behavior.

Recycling carbon fibre scrap into functional nonwovens

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Abstract

The production of carbon-fibre reinforced composites (CFRC) has grown significantly in different industries. This has led to the escalation of carbon fibre (CF) waste generation in the forms of dry CF scrap and end-of-life composites. The former group accounts for around 40% of total CF waste worldwide and has identical characteristics to virgin CF. This research focuses on up-cycling dry carbon fibre waste into nonwovens using conventional manufacturing methods available in textile industry. To this end, CF scraps were carded either for one or two times followed by needle-punching of cross-lapped carded webs. The developed nonwovens were characterised in terms of their electrical conductivity, electromagnetic interference (EMI) shielding, and sound absorption. To minimize the damage on CFs, they were mixed with different ratios of thermoplastic PA6 fibres and the effects of PA6 and carding passages on the final content of CF in nonwovens were investigated. In the next stage, the surface of CF nonwovens was functionalised using ZIF-8/PDMS and the resultant oil-water separation capability was investigated. It was found that the number of carding passages affected the content of CF and resultantly other obtained features. The maximum EMI shielding effectiveness was 85dB and it was influenced by thickness and the content of CF. The thickness of PA6/CF nonwoven was found effective on the obtained sound absorption capability while 2nd carding deteriorated it. The PDMS-based coating rendered the nonwovens superhydrophobic-superoleophilic and gave rise to an excellent oil-water separation up to 15 cycles via continuous and gravity-driven separation systems.

DEVELOPING TRAINING FROM INDUSTRIAL DESIGN TO INNOVATIVE DESIGN IN VIETNAM

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Abstract

Under the influence of industrial revolutions 4.0 and 5.0, the design industry in the world and in Vietnam has undergone a process of transformation from designing a single product to designing for industrial production. A team of trained designers is the foundation for this transformation process to be methodical and in the right direction. The global study of the transformation process of design types, concepts, classifications, and processes, as well as its application in all spheres of life, forms the basis for the objective, content, and methodology of human resources training programs in the design industry. This article provides a summary of the development process of typical design concepts and research findings on the current situation, trends, and requirements of the design industry in Vietnam and around the globe. On this basis, propose directions for enhancing design training knowledge and human resources in Vietnam's current economy.

INFLUENCE OF LINEAR DENSITY OF POLYAMIDE PLATING YARN ON THE USAGE AND COMFORT PROPERTIES OF MEN'S COTTON SOCKS

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Abstract

Socks, being a necessary item of clothing, must be comfortable and maintain their quality throughout their life. Therefore, it is very important to select the yarns for their production. Usually, casual socks are made of a high percentage of cotton to ensure softness and comfort, and blended with polyamide to improve fit, durability and shrink resistance. The objective of this study is to compare five groups of black colored cotton calf-length men's socks produced under the same conditions in full plating with different textured polyamide 6.6 multifilament yarns, designated as: 22dtex f7x2, 33dtex f10x2, 44dtex f13x2, 78dtex f23x2, 110dtex f34x2. The influence of the linear density of the polyamide plating yarn on the usage properties of the socks was evaluated by testing abrasion resistance with the Martindale abrasion tester, dimensional stability and color fastness to washing, perspiration and rubbing, as well as on comfort-related properties by testing moisture absorption, air permeability and thermal resistance with the Thermal foot manikin system. In addition, the basic physical properties of the socks, consisting of density parameters, mass and thickness were measured, all according to the standardized test methods. The results show that increasing the linear density of polyamide 6.6 yarns (i.e., increasing the amount of polyamide in the socks) has the following effects: increase in mass, thickness and structural change of sock plain knits, increase in abrasion resistance and change in dimensional stability of socks, decrease in moisture absorption, air permeability and thermal comfort of socks.

A Recycling Approach of Thermoplastic Polyurethane Films for 3D Printing Textiles

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Abstract

The increase in waste of thermoplastic polyurethane (TPU) films aggravates environmental pollution as the TPU films are difficult to biodegrade. To reuse the TPU films, a high-value-added recycling approach is expected to develop. This work introduces a practical approach to recycling TPU materials which can produce flexible filaments for 3D printing textiles. Recycled TPU (rTPU) filaments have been directly produced by waste TPU films without any additives. 3D printed samples using the rTPU filaments present exceptional elasticity with good elongation under uniaxial tension, owing to the soft segments of rTPU. As the exceptional mechanical properties, the developed rTPU filaments have been used for 3D printing textiles. During the 3D printing process, structural patterns are program-generated by a Cura 3D printing slicer. The slicer can generate and control the flexibility of 3D-printed line patterns of textiles. The study has revealed that 45°-rotated and low-infill-rate patterns can increase flexibility in bending and stretching. Anisotropy performance in two directions is observed when the intersection angles decreased from 90° to 30°. The flexibility increased in x-direction and reduced in y-direction, endowing the 3D printed textiles with different mechanical properties in two directions. The waste TPU films can be recycled and produced into flexible filaments for 3D printing applications. It is a significant recycling approach can not only protect the environment by recycling waste of TPU films but also save material and energy which can reduce manufacturing cost.

Effect Evaluation of Repeated Compression for Tactile Hardening of Cotton Pile Towel by Indentation Test

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Abstract

Pile materials have a tissue structure containing cavities and voids, and their texture hardens after repeated use. It's crucial to evaluate the hardening characteristics of pile texture numerically for products such as towels. This study aims to establish an objective procedure to evaluate the pile's hardening due to repeated use. Stability in measured results is crucial to determine product specifications. Therefore, investigating objective testing procedures for the repeated use of piles is necessary for comfortable design of pile products. In this study, a towel specimen is folded twice to achieve four layers of pile textile and repeatedly indented by a spherical resin probe. The stiffness changes of the towel due to repeated indentation are evaluated using physical contact theory based on the Hertzian theorem, which is established in 1881 and used in various fields of life. The analysis procedure is to compare the variation of physical properties defined by the extended contact theorem of Hertzian, and it is discussed by the results of 20 times indentation. In this analysis, the critical times of repeated indentations are adopted to discuss the characteristics of hardening behavior of cotton towels. As a result of repeated indentation analysis, it was shown that the change in the critical indentation number can physically quantify the characteristics of the hardening behavior of towels.

Computational Evaluation of Weaving Process on Mechanical Stiffness of Plain Weave Fabric

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Abstract

Structural inherent stress in plain weave is induced during fabrication process of fabrics, and its evaluation is useful to estimate the mechanical stiffness of the weaves. In this paper, the effect of inherent stress distributed in weave fabric is investigated to estimate the mechanical stiffness of the weaves. Here, a numerical simulation method imitating the fabrication process of fabrics is proposed for evaluation of the stiffness. The diagram illustrating the procedure of weaving process is defined in the method of this evaluation. As for computational analysis, a unit cell model used in homogenization is developed based on the structural periodicity of plain weave structure by finite element method. Weaving state is accomplished by the simulation of weaving behavior on this model. The weaving state includes the geometric shape and stress/strain data. Then, a model evaluating the stiffness is built to estimate the mechanical stiffness based on the data of weaving state data. Finally, uniaxial tension simulation is conducted on this numerical model. With this evaluation method, the effect of intrinsic stress on the mechanical stiffness of weaves is quantified, and it indicates that tension stiffness is improved in the small strain range. The effect becomes gradually smaller as tension progresses.

LIGHTNESS AND HUE DEPENDENCIES OF COLOR DIFFERENCE THRESHOLDS IN TEXTILES UNDER HIGH-ILLUMINANCE CONDITIONS

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Abstract

In this study, the color difference thresholds of the human eye for textiles in a wide range of colors under high-illuminance conditions were examined. As the high-illuminance conditions, 2856 K-2000 lux and 6504 K-2000 lux, which are in the range of illumination conditions used in spaces that highlight products such as show windows, were used. It was observed that people cannot generally perceive color differences in textiles smaller than 4.29 ΔE^*_{ab}. Also, the color difference threshold varied depending on the color center and lightness of the textiles observed. Color differences in red and blue colored textiles were easier to be perceived than other colored textiles, while those

in yellow colored textiles were the hardest to be perceived. It was also found that people are generally better able to discriminate colors between dark textiles than between light textiles. Meanwhile, the correlated color temperature of the illuminant, that is, whether it was a warm-white (2856 K) illuminant or a cool-white (6504 K) illuminant, did not significantly affect people's perception of color differences in textiles under high illuminance conditions.

COMFORT PROPERTIES AND ANTIMICROBIAL ACTIVITY OF COTTON AND NYLON/PU KNITS TREATED WITH MICROCAPSULES CONTAINING SEA BUCKTHORN OIL

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Abstract

This study was performed to investigate comfort properties and antimicrobial activity of cotton and nylon knits treated with microcapsules containing sea buckthorn fruit oil reported as having antimicrobial efficacy depending on concentration of microcapsules and treatment types. Chitosan-arabic gum microcapsules containing sea buckthorn fruit oil were prepared and they were treated on cotton and nylon/PU knit respectively by an experimental design of 2 different treatment types (bath immersion method and screen printing method) X 5 different concentration levels of microcapsules (20, 30, 40, 50, and 60% owf). As comfort properties, stiffness, water-vapor permeability, and air permeability were measured objectively. Antimicrobial activity was evaluated by calculating the percentage reduction of the bacterium. As results, stiffness values of the treated knits were slightly higher than those of untreated ones, which was thought not to affect touch in wear. The values of water-vapor permeability and air permeability of both cotton and nylon after the treatment were not significantly decreased. These results means that microcapsules loaded on the knits might not worsen their wear comfort. As for antimicrobial activity, more than 90% of bacterial reduction rates against S. Aureus were shown in cotton jersey by screen printing even after repeated laundry while those was found in nylon/PU tricot by bath immersion. From these results, it was concluded that chitosan-arabic gum microcapsule containing sea buckthorn fruit oil could be utilized for textiles to provide antimicrobial activity.

Improved horizontal wicking test for incontinence applications

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Abstract

Given ageing populations, bed ulcers and incontinence become increasingly prevalent. To ensure the success of patient support systems and incontinence applications, maintaining an optimal skin microclimate is essential. When choosing materials, accurate evaluations of fabric moisture liquid management are vital. Understanding the wicking rate and direction of a fabric directly indicates its ability to effectively spread liquid. In incontinence pads, the wicking direction is highly relevant as the liquid should ideally spread in a way that avoids leakage from the any of the pad's edges. The moisture management tester AATCC 195 detects the radial liquid spreading with electrical sensors but is not able to distinguish wicking rates in warp and weft direction from one and other, which means that cases of irregular wetting cannot be properly studied. On another note, the horizontal wicking test AATCC 198 lacks guidelines for precise measuring of the dynamic wicking behavior. The MMT does not provide any visualization of the wicking behavior while the horizontal test leaves it entirely up to the observer at the time of assessment. In this study, we modified the AATCC 198 test and applied it to test horizontal wicking in knitted fabrics. The developed method with video recording, and image processing tools, gave successful results in detecting wicking areas, rates, and distances in warp and weft direction in knitted fabrics. The improved horizontal wicking test, with its resource-efficient approach, can therefore be a valuable tool in optimizing healthcare and hygiene supporting products, particularly in enhancing liquid spreading and distribution.

Improving the Tear Strength of Low Weight Wool/Lycra Flannel Fabrics by Cordura Reinforcement

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[1]Marmara University, Istanbul, Turkey. [2]Istanbul Technical University, Istanbul, Turkey. [3]Altınyıldız, Istanbul, Turkey

Abstract

Surface milling process applied to low-weight wool/Lycra fabrics, depending on customer requests, causes poor tear strength and abrasion resistance. The purpose of this study is to improve the tear strength and abrasion resistance of low weight wool/Lycra fabrics by integrating CORDURA fiber, which shows high performance against tearing and abrasion, into wool/Lycra yarn structure. Wool/Lycra/Cordura fabrics that can be suitable for daily wear were designed in plain fabric constructions, and the physical properties of these fabrics were compared with wool/Lycra fabric. By this way, it is aimed to meet the needs of customers, who have expectations of high tear strength and abrasion resistance in thin flannel wool fabrics.

THE DURABLE CHITOSAN FINISHING OF COTTON AND COTTON/POLYESTER BLENDED FABRICS

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University of Zagreb Faculty of Textile Technology, Zagreb, Croatia

Abstract

Chitosan is a naturally occurring biopolymer that can be produced inexpensively. It is an environmentally friendly agent that has good biocompatibility, bioabsorbability, wound healing, hemostatic, anti-infective, antibacterial, non-toxic and adsorptive properties, and is usually used to achieve the antimicrobial properties of textiles. Due to the increasing requirements for the stability of antimicrobial properties over several maintenance cycles, many authors are researching to permanently bind chitosan to the textile substrate. Therefore, the aim of this research was the durability of chitosan finishing of cellulosic textile substrates, cotton and cotton/polyester blended fabric, using maleic acid as binder and sodium hypophosphite monohydrate as catalyst. For the purpose of determination of the durability of chitosan finish, after the finish, fabrics were washed according to ISO 6330:2012 using Reference detergent 3 and dry according Procedure F. Fabrics were submitted to 10 maintenance cycles. The ability of maleic acid to crosslink chitosan with cellulose substrates was monitored using Fourier infrared spectrometry in the ATR technique (FTIR-ATR) after 3rd and 10th cycle. The change in mechanical properties according to ISO 13934-1:2013 were determined as well. Maleic acid proved to be a good crosslinking agent for chitosan resulting in durable finish. The mechanical damage of cotton fabrics is greater than the mechanical damage of the cotton/polyester blend. The reason for this is the higher sensitivity of cotton to acid action compared to polyester, but also the greater number of free groups in cotton through which the acid could have penetrated.

Development of novel multi-layered nanocomposite scaffold for next-generation artificial nerve guide conduit

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[1]RMIT University, Melbourne, Australia. [2]Bangladesh University of Textiles, Dhaka, Bangladesh

Abstract

At present, peripheral nerve injuries (PNIs) are one of the leading causes of substantial impairment around the globe. Complete recovery of nerve function after an injury is challenging. Currently, autologous nerve grafts are being used as a treatment; however, this has several disadvantages, such as donor site morbidity, shortage of donor sites, loss of

sensation, inflammation, and neuroma development. The most promising alternative is the development of a nerve guide conduit (NGC) to direct the restoration and renewal of neuronal axons from the proximal to the distal end to facilitate nerve regeneration and maximize sensory and functional recovery. This research will develop a biodegradable, biocompatible, mechanically robust, and electrically conductive multi-layered nanocomposite next-generation nerve conduit scaffold that will provide directional nerve regeneration and promote functional and sensorial recovery after regeneration. The developed NGC can be connected to wireless electrical stimulation to send the electrical currents in particular directions from the proximal to the distal nerve stump for better directional nerve growth on longer nerve gaps.

MOVING SMART TEXTILES TOWARDS SUSTAINABILITY: ENVIRONMENTALLY FRIENDLY PROTECTIVE COATING FOR ELECTRICALLY CONDUCTIVE YARNS

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[1]Technische Universität Dresden, Institute of Textile Machinery and High Performance Material Technology, Dresden, Germany. [2]Centre for Tactile Internet with Human-in-the-Loop (CeTI), Dresden, Germany

Abstract

Current research focuses on advancements and breakthroughs in the realm of smart textiles, with applications spanning various industries such as medicine and education. For producing flexible smart textiles, electrically conductive yarns (EC) are needed to transmit signals or as part of sensor systems. Mostly, these EC consist of a polymer core with an outer metallized layer. Using EC in contact with skin requires high reliability and safety, and thus, the EC must maintain their functional properties on a long-term scale under a range of different stresses. The electrical properties of EC deteriorate under mechanical stress applied during production or in-use through damage to the yarn's surface. At present, there are only partially feasible solutions to protect the metal-layer of the yarn surface. Hence, this paper presents a newly developed non-toxic coating (NTC) to protect the EC surface. The NTC consists of an aqueous emulsion with polypropylene wax and oxidized wax. To determine the long-term stability of the coating, the produced yarns undergo comprehensive evaluation using a range of analytical techniques. The aim is to identify the optimal coating process by exploring different equipment and parameters. Additionally, it is various test methods to gauge the durability of the newly developed NTC used and ensure its reliability over time. To characterize the yarn properties before and after the coating Soxhlet extraction, Fourier transform infrared attenuated total reflection spectroscopy (FTIR), thermogravimetric analysis, light microscopy, scanning electron microscopy (SEM), and surface free energy (SFE) analysis, a gravimetric analysis and resistivity measurement are conducted.

FABRICATION STRATEGIES TOWARDS MXENE-BASED MULTI-FUNCTIONAL FIBERS

Ken Aldren Usman, Jizhen Zhang, Joselito Razal
Deakin University, Institute for Frontier Materials, Geelong, Australia

Abstract

The recent interest in portable and wearable electronic devices has driven a huge demand in manufacturing multifunctional fibers and yarns that can ubiquitously integrate with common textile materials. However, one gap stalling the development of such devices is the challenge in producing robust and functional fibers capable of either conducting electricity or storing/generating energy. To address these demands, recent efforts have been made towards the use of 2D transition-metal carbides (also known as MXenes) in the production of such functional fibers. Particularly, $Ti_3C_2T_x$ MXene, which is known for its metal-like conductivity (>20,000 S cm^{-1}) and excellent electrochemical capacitance (>2,800 F cm^{-3}), is a promising as active material for fibers, either as a coating material or an additive to the main fiber components. Here, we summarize the diverse efforts of fabricating MXene-based functional fibers, which include methods such as (1) direct coating of fiber substrates, (2) wet spinning of pure and

composite MXene dispersions and (3) trapping of MXene into host galleries. We also evaluate the typical challenges observed in each processing technique, along with proposed solutions to significantly enhance both macroscale properties and performance of the resulting fibers and their prototype devices. We envisaged that addressing such foreseen challenges would greatly contribute to the advancement of MXene-based fibers towards practical applications, providing future avenues for smart textile design and practical their use in advanced applications.

Posters

Preparation of cellulose/graphene oxide films crosslinked by vinyltrimethoxysilane

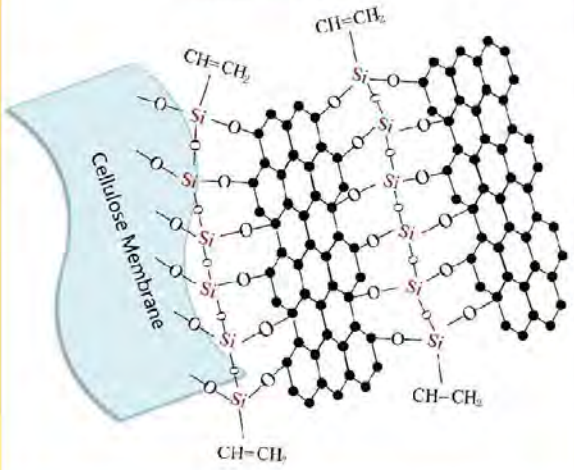
Xiaodong Tan

Department of Material Engineering, Faculty of Textile engineering, Technical university of Liberec

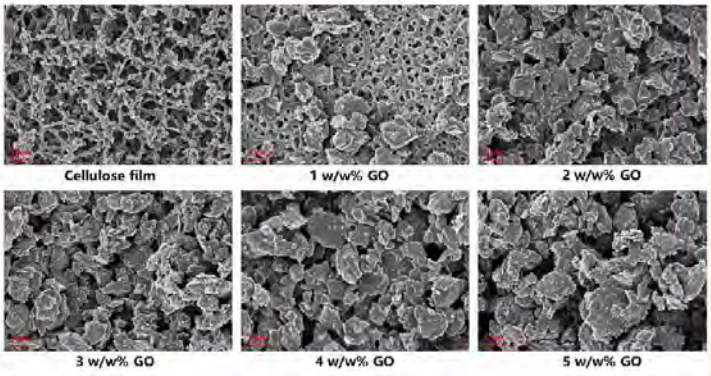
ABSTRACT

In this study, we adopted a simple and environmentally friendly silane crosslinking method to crosslink cellulose and graphene oxide (GO) together. The cellulose/GO hybrid membrane were characterized by FTIR, SEM, surface resistance. Results show that the covalent bond between cellulose and GO was formed by vinyltrimethoxysilane (VTMS), and GO was successfully cross-linked on the surface of the cellulose membrane. In addition, it also exhibits extremely low surface resistivity (720.69 Ω). It shows great potential conductive membrane as electronic device.

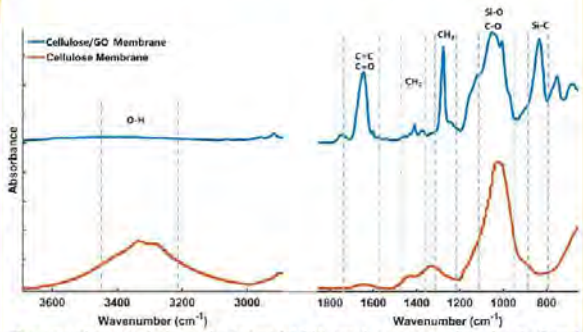
Introduction



Surface Morphology

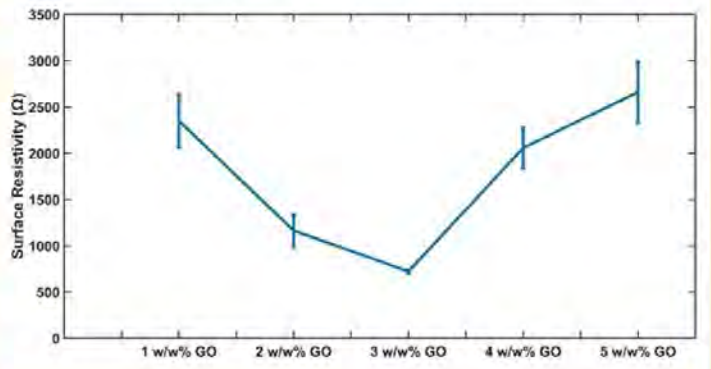


Characterization of Cellulose/GO Structure



The new characteristic peaks around 1645 cm-1 correspond to the C=C and C=O stretching vibrations of GO. The characteristic peak observed at 1411 cm-1 is attributed to the stretching vibration of CH2 on VTMS. Also, the peak at 1276 cm-1 is due to the vibration of CH3. The unique characteristic peak of cellulose can be observed around 1050 cm-1, which is attributed to the C-O-C stretching vibration of the glycosidic ring. However, a shoulder peak at 1008 cm-1 can be observed in the cellulose/GO spectra, confirming the presence of Si-O. The peaks appearing from 700 cm-1 to 850 cm-1 are attributed to Si-C bonds. The appearance of these peaks confirms that complete hydrolysis of VTMS achieving cellulose/GO cross-linking. Interestingly, the OH stretching vibration of the cellulose/GO films almost disappeared after silanization, which may be due to the complete hydrolysis of VTMS and the formation of condensation and esterification with the hydroxyl groups of GO and cellulose forming (Si-O)n chains.

Adsorption Performance



ACKNOWLEDGMENT

The work was supported by the research project of Student Grant Competition of Technical University of Liberec no. 2023-6374 granted by Ministry of Education Youth and Sports of Czech Republic.

ENHANCED SIDE-ILLUMINATION OF ETCHED POLYMER OPTICAL FIBER (POF)-INCORPORATED WOVEN POLYESTER (PET) FABRICS

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[2] Institut für Textiltechnik, RWTH Aachen University, Otto-Blumenthal-Straße 1, 52074 Aachen, Germany

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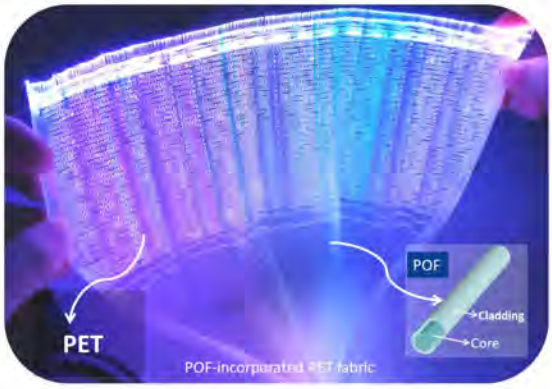
1. Introduction



Polymer optical fibers (POFs) are used as a medium for transmitting light on textiles to produce illuminating effects.

When POFs are being selected for linear illumination, bending losses lead to non-uniformity of luminance . However, the yarn-like character of POF offers many possibilities for its integration into planar fabric . Through typical textile processes, such as knitting , weaving and embroidery , it is possible to incorporate a number of regularly bending POFs in sets adjacent to each other for planar lighting.

Many efforts have been devoted to the enhancement of side illumination of POF by creating micro-perforations for leakage of light. Current techniques for removing the cladding can be divided into mechanical and chemical methods

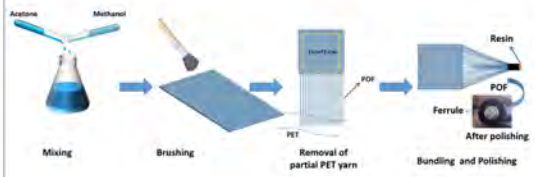
In this work, POFs and polyethylene terephthalate, commonly known as polyester (PET) yarns were interwoven together as a asymmetric fabric with 1/3 twill structure. Then a mixture of acetone and methanol in a volume ratio of 1:1 was applied to treat the POF-incorporated PET fabrics for 1 min. To investigate the effect of acetone and methanol on the side lighting properties of POF-incorporated PET fabric, both surface morphology and side illumination behavior were studied.

2. Experimental

Materials

The polymer optical fibers (Jiangxi Dashing POF Co., Ltd, Jiangxi, China) with a diameter of 0.25 mm were used.

Preparation of etched POF-incorporated PET fabric



Tests and methods

Scanning electronic microscopy (SEM) (VEGA TESCAN Inc., Lincoln ,USA) and the laser optical microscopy (LOM) (OLS5000 LEXT, Tokyo, Japan) were used to characterize the morphology of the etched fabric.

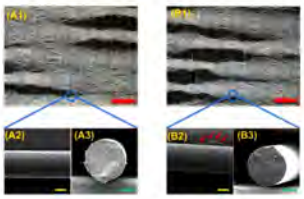
Side illumination behavior of all samples was measured by the Tru-Image TRU8 Imager (PHOTO RESEARCH, Inc., USA). The RGB light source "LS100-RGB-1" from French company Brochier Technologies, Villeurbanne, France was used. The measurements were taken in the dark environment

3. Results and discussion

3.1 Effect of acetone/methanol etching on morphology on the POF-incorporated PET fabric

After acetone/methanol etching process, the structure of POF-incorporated PET fabrics was still kept.

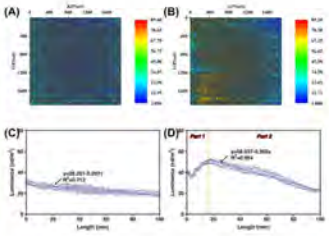
The cladding of the composition as a fluorinated polymer was disrupted by the acetone/methanol mixture.



3.2 Effect of acetone/methanol etching on side illumination of POF-incorporated PET fabric

The etched POF-incorporated PET fabric was more visible than reference sample by observing higher luminance.

The linear models ($y=a+bx$) for reference sample and etched POF-incorporated fabric were fitted.



4. Conclusion

The acetone/methanol destroyed cladding layer of POFs while had a slight effect on the whole structure of POF-incorporated PET fabric. Then, the side illumination intensity of etched POF-incorporated PET fabric was enhanced, while the light attenuation coefficient was decreased. Besides, the side illumination intensity along propagation direction firstly increased and then decreased. The optical coupling effect could be one important factor. As a result, the length of etched POF-incorporated PET fabric as 16.21 mm was for optimal side illumination intensity.

5. Acknowledgement

The work was also supported by the research project (No. SGS-2023-6353) of the Student Grant Competition of Technical University of Liberec granted by the Ministry of Education, Youth and Sports of Czech Republic.

Recycling carbon fibre scrap into functional nonwovens

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Aims of research

- Up-cycling carbon fibre (CF) dry waste into functional nonwovens
- Using conventional textile machineries for processing dry CF waste
- Understanding the EMI shielding and sound absorption properties of CF nonwovens
- Developing CF nonwovens with superhydrophobic and superoleophilic properties for oil-water separation

Background

The total annual growth of CF in different industries has experienced a significant growth in recent years [1]. This has led to the great escalation of CF waste generation in the forms of CF-reinforced composites and dry CF scrap. The latter one is mainly produced during the manufacturing process of composites as offcuts and bobbin ends. Dry CF waste accounts for around 40% of total waste in this area and therefore needs further attention for recycling into novel functional products. Figure 1 shows some common methods of processing CF waste.

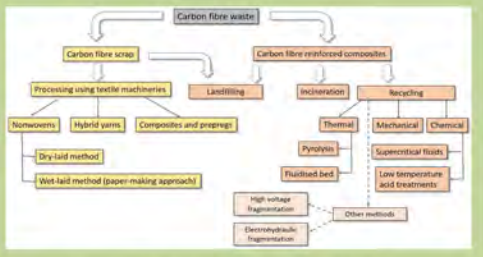

Figure 1: CF waste recycling methods [1]

In this research, CF dry waste was recycled into nonwovens through carding and needle-punching techniques. To alleviate the CF damage during the carding process, they were blended with different ratios of PA6 fibres which acted as carrier fibres [2].

Figure 2: CF/PA6 nonwoven production

CF nonwovens were produced based on:

- CF/PA6 20/80, 50/50, 80/20 ratios
- 1 and 2 carding passages
- 2 and 4 cross-lapped layers

Figure 3: CF/PA6 nonwovens [2]

Results

- Increasing the content of CF led to a higher EMI shielding effectiveness [2]
- CF/PA6 nonwovens showed a promising performance in sound absorption [2].
- Excess carding passages reduced the EMI shielding effectiveness by reducing the content of CF in nonwovens [2].

Figure 4: Applications of CF/PA6 nonwovens

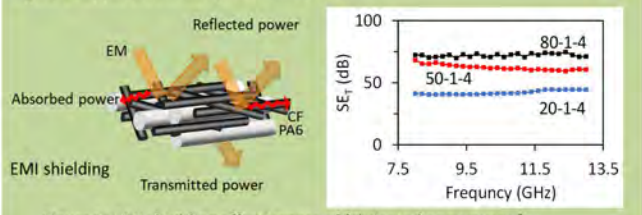

Figure 5: EMI shielding effectiveness of fabricated nonwovens [2]

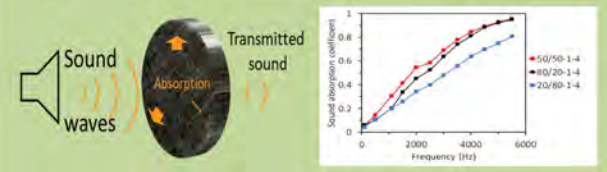

Figure 6: Sound absorption mechanism and performance of nonwovens [2]

Figure 7: Preparation of functional nonwoven for oil-water separation [3]

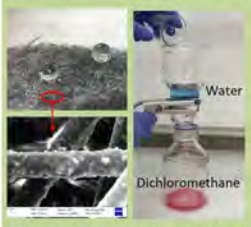

Figure 8: nonwoven coated with ZIF-8/PDMS, and oil-water separation set-up [3]

- Nonwovens were treated with ZIF-8/PDMS for oil-water separation [3]
- Amount of PDMS was effective on water contact angle of nonwovens
- Excess PDMS reduced oil absorption [3]
- Nonwovens showed excellent performance in gravity-driven and continuous oil-separation systems
- Oil-water separation was tested up to 15 cycles. [3]

Summary of Key Findings

- CF dry scrap can be processed using textile nonwoven machineries
- PA6 amount was effective in reducing CF damage during carding
- CF/PA6 can be used as a lightweight product for EMI shielding and sound absorption application
- EMI shielding effectiveness up to 85 dB was obtained.
- 2nd carding reduced the sound absorption of nonwovens
- CF nonwoven had an excellent performance in oil-water separation

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Developing Training from Industrial Design to Innovative Design in Vietnam

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ABSTRACT

Under the influence of industrial revolutions 4.0 and 5.0, the design industry in the world and in Vietnam has undergone a process of transformation from designing a single product to designing for industrial production. A team of trained designers is the foundation for this transformation process to be methodical and in the right direction. The global study of the transformation process of design types, concepts, classifications, and processes, as well as its application in all spheres of life, forms the basis for the objective, content, and methodology of human resources training programs in the design industry. This article provides a summary of the development process of typical design concepts and research findings on the current situation, trends, and requirements of the design industry in Vietnam and around the globe. On this basis, propose directions for enhancing design training knowledge and human resources in Vietnam's current economy.

INTRODUCTION

Currently, in Vietnam, there is a fairly common situation that graduates who graduated from art design schools have many design products which have high aesthetic value and are difficult to apply in actual production in enterprises. As for bachelors and engineers trained from technical schools, they mainly focus on improving knowledge about the technology of products, and solutions on design offered can have high technological value. However, the vast majority lack the aesthetic appeal that attracts customers.

Industrial Design → Creative Industries → User-centric design → Innovative design

Research and generalize from industrial design to innovative design with some related concepts and classifications. From there, determine the factors affecting the designing of today's products. To design good products, designers must have the corresponding background and knowledge. The nature of innovative design needs to be clearly defined to apply for research and training. *With the constant fluctuations of the world and the current socio-economic situation, synthesizing and giving suitable assessments and solutions on industrial design and innovation design in training human resources is the aim of this paper.*

OBJECTS

- Design concepts involved in the evolution of industrial design.
- Training industrial design and innovation design in Vietnam and around the world.
- The training program of the typical schools has industrial fine art and innovative design in the world and Vietnam.
- Design market and design human resources situation, design field: Fashion design, graphic design, product design, web design.
- Application situation of training supplementary knowledge on industrial design at Hanoi University of Science and Technology.

METHODS

- Collecting, systematizing, summarizing, analyzing, and evaluating data were used throughout this study.
- Historical research divides development stages to see some concepts related to industrial design and innovative Design.
- Investigation, statistics, and assessment of human resource needs in the design industry and design training in the world and Vietnam.
- Experimental teaching and directly designing, summarizing, evaluating, and proposing solutions to develop the designing - human resources for Vietnam today.

RESULTS

The market situation of design services and innovative industry in the world

The market situation of design services and innovative industry in Vietnam

The situation of design training in the world

Universities update and develop innovative trends in educational design

The situation of training in Industrial Fine Arts in Vietnam

Design education and training institutions are structuring programs biased toward artistic or technical design in Vietnam.

Fig1. Product of Industrial Fine Arts students

Fig 2. Technological products of HUST students

Fig 3. The product is a combination of fine arts and mechanical engineering

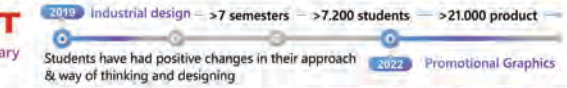
Proposing some solutions for the development of innovative design training in Vietnam

Summarize the typical format of existing design training programs in Vietnam and propose an appropriate program format to open the training sector. Based on research, summarize and evaluate the situation of innovative design training in the world, the actual training situation in Vietnam, and the process of implementing training of all types of design in Vietnam.

Fashion Technology	Linking scientific and technological resources, combined with the aesthetic background. Graduates enable to design, develop explanatory materials, demonstrate or display collections, and evaluate solutions, systems/ processes/ products in the creative design industry. New materials research, technologies, and digital applications for Innovative design, production, promotion, distribution, and sales.
Technology Product Design	The characteristics of the industry are developed based on technology engineering combined with Industrial Aesthetics. Create products that are functional and aesthetic, especially capable of producing on an industrial scale and highly commercial in the market and user experience.
Visual Communication Design	Research on the latest trends and apply new software for multimedia graphic design. Create, process, and share potential multimedia designs with security optimization. Check the quality of each device and platform using pixel optimizer and create the best processing solutions. Understand and optimize the interacion and impression of visual media and user.
Web and Application Design	Research on various website styling, speed, and quality resolution for products and services. Optimize content display with marketing standards while keeping the brand intact. Create a visually appealing platform with optimized graphics with SOS tools and techniques. Check and minimize the risk of website crashes and optimize SSL licensing with content license. Create product presentation standards with all conditions and results optimized for quality.

Proposing additional directions and developing design training for the design industry in Vietnam

- Supplementing knowledge about Industrial design, Innovation, and Promotion for Students of Engineering and Technology.



- Supplementing technical knowledge and updating the development of Science and Technology for students majoring in Art Design.
- Developing an innovative design training project is a broad and interdisciplinary combination that is a new path in a training model and suitable for world trends, overcoming inherent limitations because of the separation of the two disciplines of engineering and fine arts in training in Vietnam.

CONCLUSION

From the system, summarize the evolution of typical design concepts in history to see the influencing factors and development of these concepts. On that basis, conduct a review, research, summarize and evaluate the situation of Vietnam's design market, essentially the demand for human resources for the design, classify the background design industries that have human resource needs in Vietnam, thereby proposing a plan to supplement the knowledge and develop human resource training designed to promptly respond to the development of the current economy in Vietnam.

ACKNOWLEDGEMENTS

The article refers to the actual data collected from the research and teaching of the Innovative Design Group that has been done in the past time with the cooperation of experts. The authors would like to thank the Innovative Design Group, Faculty of Mechatronics, School of Mechanical Engineering, Hanoi University of Science and Technology and experts.

INFLUENCE OF LINEAR DENSITY OF POLYAMIDE PLATING YARN ON THE USAGE AND COMFORT PROPERTIES OF MEN'S COTTON SOCKS

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Introduction

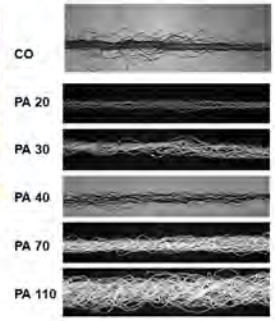
Socks, being a necessary item of clothing, must be comfortable and maintain their quality throughout their life. Therefore, it is very important to select the yarns for their production. Usually, casual socks are made from high content of cotton to ensure softness and comfort, and blended with polyamide to improve fit, durability and shrink resistance.

Materials

The objective of this study is to compare five groups of black colored cotton calf-length men's socks made of cotton (using single ring spun cotton yarn of linear density 29.4 tex) in full plating with different textured polyamide 6.6 multifilament yarns, designated as: 22 dtex f7 × 2 (**PA 20**), 33 dtex f10 × 2 (**PA 30**), 44 dtex f13 × 2 (**PA 40**), 78 dtex f23 × 2 (**PA 70**), 110 dtex f34 × 2 (**PA 110**).

The plain single jersey pattern was used in the foot and leg part, and a 1 × 1 rib structure was used in the cuff of the socks. The socks were produced under the same conditions in Jadran Hosiery, Croatia, using Lonati sock knitting machine E14 of cylinder diameter 88.9 mm (3 ½") with 168 needles and were ironed at a temperature of 110 °C using a Cortese machine. Socks are designated according to the code of the PA 6.6 plating yarn used (**CO/PA 20 – CO/PA110**).

Automatic sock knitting machine, Lonati



Optical microscopy images of yarns

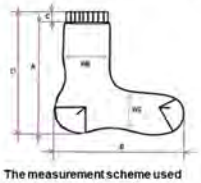
Tested socks

Cutting the socks and sampling of the test specimens

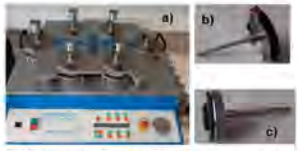
Methods

The influence of the linear density of the polyamide plating yarn on the usage properties of the socks was evaluated by testing abrasion resistance with the Martindale abrasion tester, color fastness to washing, perspiration and rubbing, and dimensional stability as well as on comfort-related properties by testing moisture absorption, air permeability and thermal resistance with the Thermal foot manikin system. In addition, the basic physical properties of the socks, consisting of density parameters, mass and thickness were measured, all according to the standardized test methods.

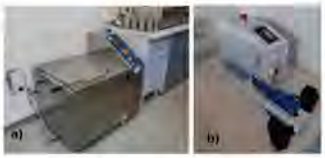
Prior to measurement, sock samples were conditioned on a flat surface for at least 24 h in a standard atmosphere with a temperature of 20 ± 2 °C and a relative humidity of 65 ± 4 %. For all the tests on the sock knits, the socks were cut open and sampled.



The measurement scheme used for socks dimension



Abrasion resistance: a) Martindale abrasion tester, sample holders for b) pilling and c) abrasion



Color fastness: a) to washing tester, b) electronic crock meter for rubbing

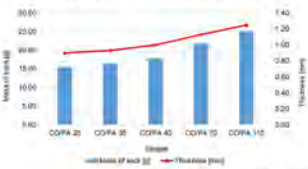
Air permeability Tester

Thermal foot manikin system

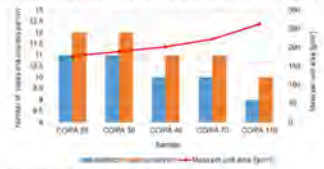
Results and discussion

The results show that increasing the linear density of polyamide 6.6 yarns (i.e., increasing the amount of polyamide in the socks) has the following effects: increase in mass, thickness and structural change of sock plain knits, increase in abrasion resistance and change in dimensional stability of socks, decrease in moisture absorption, air permeability and thermal comfort of socks. The linear density of polyamide 6.6 plating yarns did not affect the colour fastness of socks significantly.

Influence of PA 6.6 yarn linear density on the mass of the whole sock and thickness of sock plain knits



Influence of PA 6.6 yarn linear density on the nr. of wales and courses/cm and the mass per unit area of the sock plain knits



Legend: CO – cotton, PA – polyamide of linear density (20 – 110 dtex x 2)

Abrasion resistance of sock plain knits sampled from the heel and sole of socks

Sock sample	Number of abrasion rubs to reach endpoint	
	Sole	Heel
CO/PA 20	4000	4000
CO/PA 30	6000	6000
CO/PA 40	8000	8000
CO/PA 70	8000	8000
CO/PA 110	12 000	14 000

Visually assessed propensity to surface pilling of sock plain knits by grades of pilling

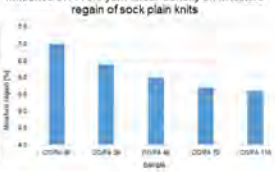
Sock sample	Number of pilling rubs					
	125	500	1000	2000	5000	7000
CO/PA 20	4/5	4	4	3/4	3	2/3
CO/PA 30	4/5	4	4	3/4	3	2/3
CO/PA 40	4/5	4	4	3/4	3	2/3
CO/PA 70	4/5	4	4	3/4	3	2/3
CO/PA 110	4/5	4	4	3/4	3	2/3

Legend: CO – cotton, PA – polyamide of linear density (20 – 110 dtex x 2)

Colour fastness of socks to washing, perspiration and rubbing

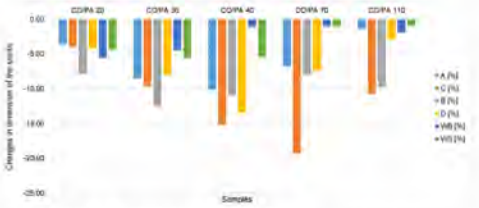
Sock sample	Washing	Perspiration		Rubbing			
		Alkaline solution	Acid solution	Length direction		Width direction	
				Dry	Wet	Dry	Wet
CO/PA 20	5	5	5	5	4	5	4
CO/PA 30	5	5	5	5	4	5	4
CO/PA 40	5	5	5	5	3/4	5	4
CO/PA 70	5	5	5	5	3	5	3/4
CO/PA 110	5	5	5	5	3	5	3/4

Influence of PA 6.6 yarn linear density on moisture regain of sock plain knits



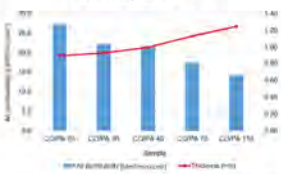
Legend: CO – cotton, PA – polyamide of linear density (20 – 110 dtex x 2)

Changes in dimensions of sock in the length and width direction after one washing and drying cycle

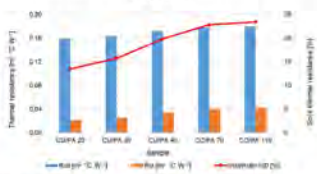


Legend: CO – cotton, PA – polyamide of linear density (20 – 110 dtex x 2)
A – length of the sock leg part, B – length of the sock side part, C – length of the sock cuff, D – length of the leg and the cuff of the sock (A+C), WB – width of the sock leg part, WS – width of the sock side part

Relation between the air permeability and the thickness of the sock plain knits



Thermal resistance of socks measured on the Thermal Foot Manikin



Legend: CO – cotton, PA – polyamide of linear density (20 – 110 dtex x 2)

Conclusion

From the obtained results, it can be concluded that when selecting the plating yarn for the production of cotton socks, it is necessary to take into account their linear density and structure, as well as the intended purpose of the socks, their specified comfort and the expected usage quality.

A Recycling Approach of Thermoplastic Polyurethane Films for 3D Printing Textiles

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Introduction

The increase in post-consumer textile waste of thermoplastic polyurethane (TPU) films aggravates environmental pollution as the TPU films are difficult to biodegrade. To reuse the TPU films, a high-value-added recycling approach is expected to develop. This work introduces a practical approach to recycling TPU materials which can produce flexible filaments for 3D printing textiles. Recycled TPU (rTPU) filaments have been directly produced by waste TPU films without any additives.

Method

The TPU films were washed and dried at 60 overnight before the reprocessing. The dried TPU textiles were shattered into small pieces which were easier for feeding. Then, the TPU pieces were fed, melted, and extruded into the rTPU filament. The rTPU filament diameter reached 1.75 mm with great roundness.

The rTPU filaments were 3D printed into program-generated rTPU textiles by different infill rates, rotated angles, and intersection angles using Cura 3D printing slicer software. Cura managed 3D printing paths and generated patterns on 0.6-mm-high solid sheet 3D models. The model height allowed two 0.3-mm-high layers to form the textile structures.

The mechanical properties of 3D-printed rTPU textiles were tested according to the Kawabata evaluation (KES-F) system including tensile and bending tests

Results and Discussion

The TPU films were directly recycled into the rTPU filament without any additives and the rTPU filament was 3D printed into rTPU textiles. The 45°-rotated rTPU textile elongated greatly and absorbed more energy (high EMT of textiles means they perform high flexibly) in tensile tests and performed the highest flexibility in bending tests (low B of textiles means they perform high flexibly), as shown in Fig. 3. The increase in the infill rate of rTPU textiles decreased the elongation sharply and absorbed less energy in tension and reduce the flexibility greatly in bending.

These results indicate this recycling approach to recycling TPU films for 3D printing textiles is practical and could increase the recycling rate of TPU films from textile wastes.

Conclusion

The TPU material recycled from TPU films exhibits high filament extrusion processability. It can be directly recycled into rTPU filament without any additives. After 3D printing, the flexibility of 45°-rotated and low-infill-rate patterned textiles increased in bending and stretching testing. Anisotropy performance in two directions is observed when the intersection angles decreased from 90° to 30°. The flexibility increased in x-direction and reduced in y-direction, endowing the 3D printed textiles with different mechanical properties in two directions. The waste TPU films can be recycled and produced into flexible filaments for 3D printing applications. It is a significant recycling approach can not only protect the environment by recycling waste of TPU films but also save material and energy which can reduce manufacturing cost.

Figure 1. Thermoplastic textile waste challenges

Figure 2. Fabrication of rTPU filament

Sample exhibition. Left: 45°-rotated angle, Right: 30°-intersection angle

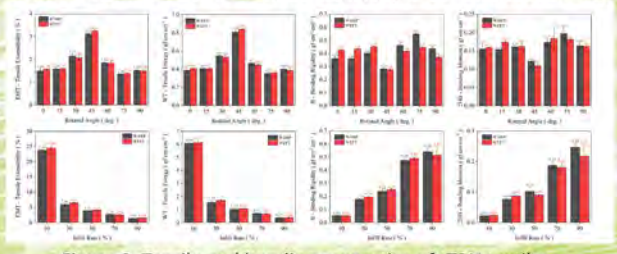

Figure 3. Tensile and bending properties of rTPU textiles

Acknowledgments

We would like to express our sincere gratitude to Dr. Sarina Sun, Dr. Liu Jun, Dr. Jianzhong Sun, and Mr. Meng Zhang who have contributed to the research and the support from the School of Fashion and Textiles of The Hong Kong Polytechnic University and School of the Environment and Safety Engineering of Jiangsu University.

Effect Evaluation of Repeated Compression for Tactile Hardening of Cotton Pile Towel by Indentation Test

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Tsuyoshi Morita(Oboro Towel Co., Ltd.), **Hideo Matsui** (Oboro Towel Co., Ltd.),

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KYOTO INSTITUTE OF TECHNOLOGY

Introduction

Here, as can be seen in Figure,piled materials such as towels have a pronounced tendency to shrink and change in softness with use.

The characteristics of the fabric structure, including numerous voids and gaps in the cotton pile material, may be responsible for this result.

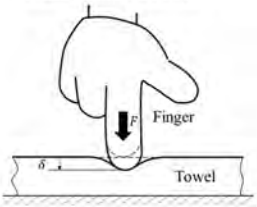
Objective

Development of a method for the determination of the conditions for the objective and stable determination of the softness of pile material.

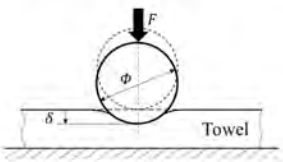
Methods

Indentation theory and elasticity

Touching a towel with a finger



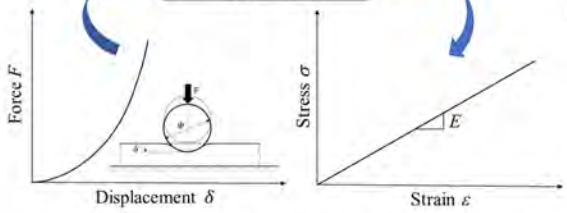
Indentation with a spherical indenter



The Indentation tests measurement process is very close in form to the actual contact process of the finger and thus has the potential to be an objective quantification of tactile sensations.

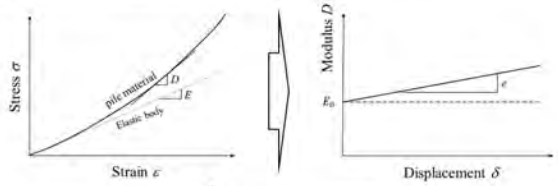
Hertzian theory(1881)

$$F = \frac{4}{3}\frac{E}{1-\nu^2}\left(\frac{\Phi}{2}\right)^{\frac{1}{2}}\delta^{\frac{3}{2}}.$$



Young's modulus E of the object under test can be calculated from the results of the indentation experiment using Hertz's theory.

Expansion into pile material evaluation

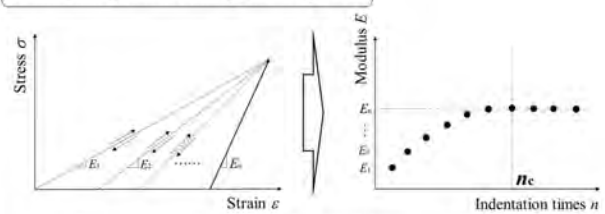


$$F = \frac{4}{3}\frac{D}{1-\nu^2}\left(\frac{\Phi}{2}\right)^{\frac{1}{2}}\delta^{\frac{3}{2}}.$$

$$D = E_0 + e\delta.$$

D: Apparent elasticity modulus
ν: Poisson's ratio
E_0: Initial modulus
e: Modulus gradient

Deformation hysteresis with repeated compression



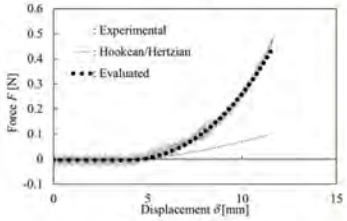
n: Indentation times n_c: Number of indentations at which the modulus of elasticity stabilizes
E_n: Modulus of elasticity at nth indentation

Confirmation by experiment

Device Information

Device	YAWASA MSES-0512
Indenter diameter	80mm
Maximum force	0.5N
Indentation speed	1mm/s

Fold the sample into four layers and repeat the indentation experiment.



Indentation times 20 (n=20)

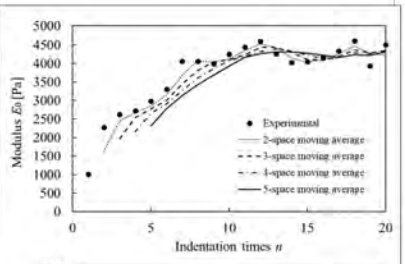
Stability Condition Analysis Formula

$$\overline{E_0}(n) = \frac{1}{N}\sum_{i=n-N+1}^{i} E_0(i)$$

$$\bar{e}(n) = \frac{1}{N}\sum_{i=n-N+1}^{i} e(i)$$

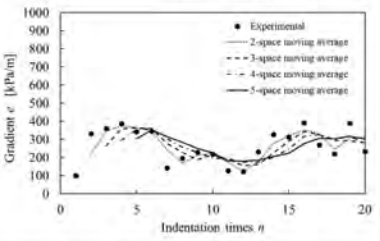
n : Indentation times

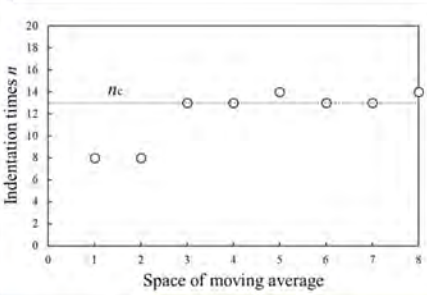
N : Space of moving average



•e was less dependent on the number of indentation times.

•The stable conditions of E_0 could be accurately determined.





The evaluation value of initial elasticity E_0 stabilized 13 times(n_c=13)

Conclusions

In the indentation test for objective evaluation of tactile sensation of cotton towel materials, a method is reported to clearly indicate the conditions under which the results of repeated evaluation of physical properties are stable.

Computational Evaluation of Weaving Process on Mechanical Stiffness of Plain Weave Fabric

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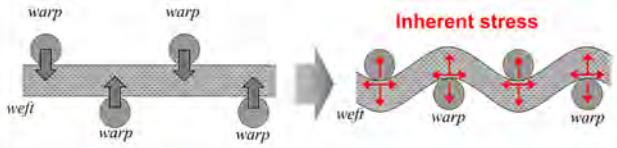
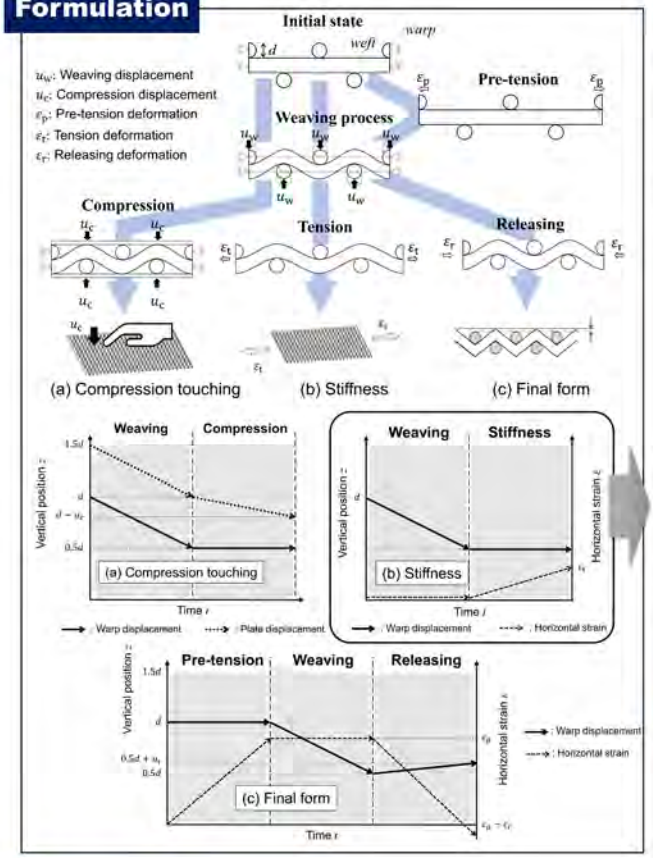
Introduction

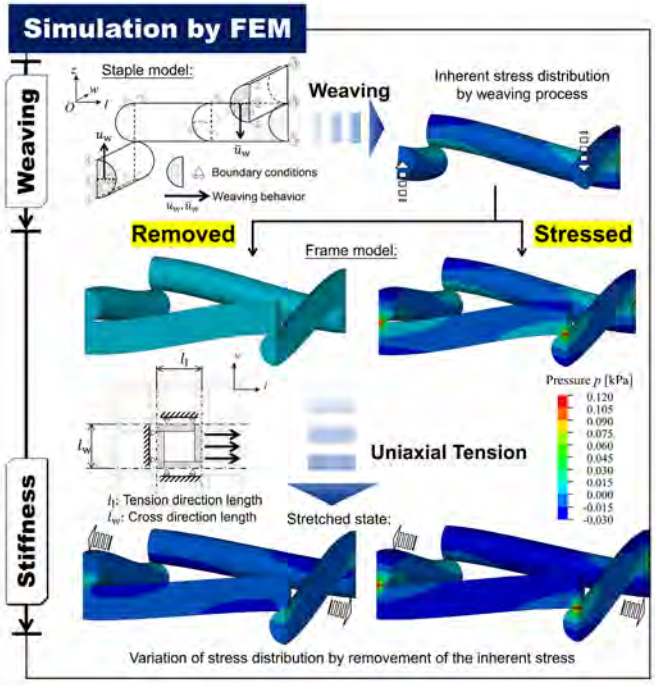


Structural inherent stress in plain weave is induced during fabrication process of fabrics, and its evaluation is useful to estimate the mechanical stiffness of the weaves. In this study, the effect of the inherent stress distributed in the weave fabric is investigated to estimate the mechanical stiffness of the weaves. Here, a numerical simulation method imitating the fabrication process of fabrics is proposed for evaluation of the stiffness.

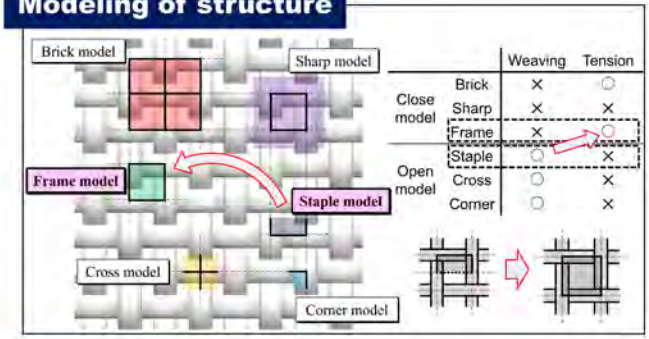
Formulation



Simulation by FEM

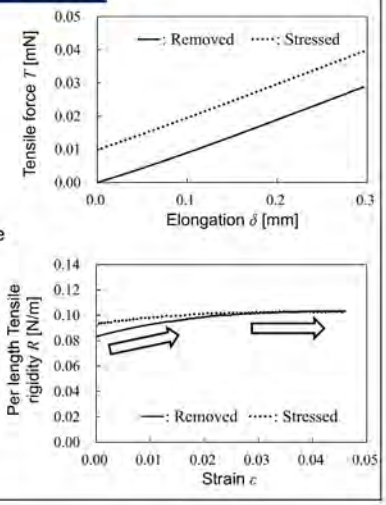


Modeling of structure



Results and discussion

- Internal stress exhibits initial resistance force.
- The inherent stress induced by weaving raised the stiffness of the fabric
- Difference of raised stiffness become small by deformation



Conclusion

In this study, diagram models for analyzing some evaluation problems using meso-scale modeling of plain woven materials are first presented, and then a method for considering inherent stress in relation to stiffness of plain woven materials is clarified.

Lightness and Hue Dependencies of Color Difference Thresholds in Textiles under High-Illuminance Conditions

Youngjoo Chae, Sungwoo Moon
Department of Clothing & Textiles, Chungbuk National University, Republic of Korea

Introduction

- For fashion and textile products, color is one of the most primary factor to which consumers react prior to overall style and price (Scully & Cobb, 2012).
- However, what plagues fashion industry is that the color appearance of textiles perceived by consumers differs depending on the environment in which the textiles are observed (Figure 1).
- Through visual assessments, this study examined the color difference thresholds of the human eye for textiles in a wide range of colors under high-illuminance conditions such as feature display and show windows.

Figure 1. Color appearance changes under different lights

Experimental

Samples

- A total of 72 cotton plain woven fabric samples with the size of 2 × 2 inch
  - 24 standard samples: 8 color centers × 3 lightness levels
  - 48 test samples: 3 test samples for each standard sample with ΔE^*_{ab}=1.70~12.44 from the corresponding standard sample

→ 72 standard-test sample pairs (Table 1)

Table 1. Standard samples (big images) and their corresponding test samples (small images)

Lightness level	Color center: R	RY	Y	YG	G	GB	B	BR
Light								
Medium								
Dark								

Physical color measurement

- The spectral reflectance (R%) values of 72 fabric samples were measured for the visible wavelength range of 360-740 nm in 10 nm increments by a spectrophotometer in SCE mode.
- The R values were then converted to lightness L^*_{10}, chroma $C^*_{ab,10}$, and hue $h_{ab,10}$ values based on CIE 10° observer and CIE illuminant D65.

Visual assessment

- The yes-no technique was employed to determine color difference thresholds under high-illuminance conditions (Figure 2).
  - Illumination conditions: 2856 K-2000 lux and 6504 K-2000 lux
  - Observers: 30 male and female observers in their 20s and 30s
  - Assessment: Observers informed whether they could detect any difference in color between the standard and test samples in each pair

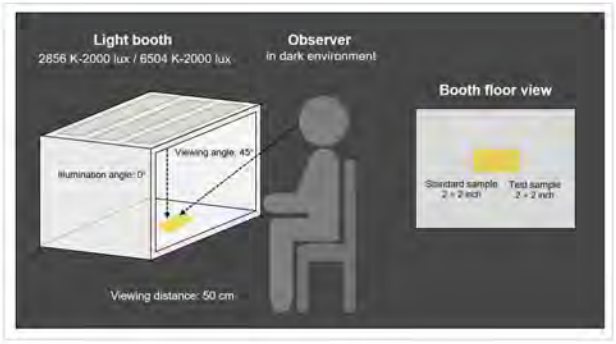


Figure 2. Method of visual assessments to measure color difference thresholds

Results

- Different color difference thresholds according to the color centers and lightness levels of sample pairs and the illumination conditions are presented in Figure 3.
  - Regardless of the color attributes of the samples, the mean threshold was 4.29 ΔE^*_{ab}, indicating that people cannot generally perceive color differences in textiles smaller than 4.29 ΔE^*_{ab} under high-illuminance conditions.
  - Among 8 color centers, color differences in red and blue colored textiles were the easiest to be perceived, while those in yellow colored textiles were the least perceptible with the highest mean threshold of 5.46 ΔE^*_{ab}.
  - People were generally better able to discriminate colors between dark textiles than between light textiles.
  - The correlated color temperature of the illuminant, that is, whether it was a warm-white (2856 K) illuminant or a cool-white (6504 K) illuminant, did not significantly affect people's perception of color differences in textiles under high illuminance conditions.

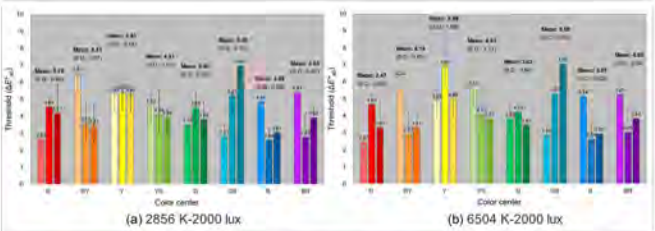


Figure 3. Varying color difference thresholds ΔE^*_{ab} depending on the color center and lightness level (in order of decreasing lightness) under high-illuminance conditions

Conclusion

- The numerical values of the thresholds found in this work will allow fashion and textile companies to plan the colors of their products efficiently.
  - For products made in various colors, the color spacing can be adjusted reasonably to create distinct image differences between the products.
  - For color quality control, different criteria can be used for different colors of textiles and thus reducing repetitive physical sampling to match to target colors.

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Comfort Properties and Antimicrobial Activity of Cotton and Nylon/PU Knits Treated with Microcapsules Containing Sea Buckthorn Oil

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1. OBJECTIVES

- To investigate comfort properties of cotton and nylon knits treated with microcapsules containing sea buckthorn fruit oil depending on concentration of microcapsules and treatment types.
- To evaluate antimicrobial activity of each treated knit for applying it to skin-health functional textiles.

Fig.1 Sea Buckthorn fruits

2. EXPERIMENTALS

Materials 1) The chitosan-gum arabic microcapsule (1.94μm) containing Sea Buckthorn fruit oil prepared by coacervation process in a previous work[7]. 2) A cotton single jersey (0.53mm, 165.6g/m^2) and a nylon/PU tricot (0.52mm, 179.6g/m^2)

Treatment 1) Two different coating method (Bath Immersion Method (BIM) & Screen Printing Method (SPM)) with a polyurethane binder applied.
2) Drying for 10 min at 80 ◦C & Curing for 5 min at 130 ℃.
3) Microcapsule concentrations in bath with a range of 20~60% (owf)

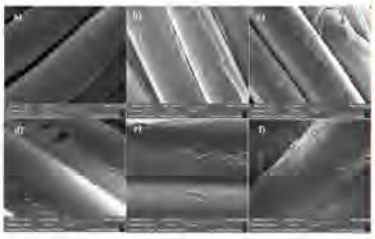

Fig.2 SEM of microcapsule-treated nylon/PU knit by SPM: a) UT, b) 20-10%, c) 30-10%, d) 40-15%, e) 50-15%, f) 60-15%(owf)

Comfort Property Measurements 1) Stiffness : drape stiffness (C) and flex stiffness (E) using cantilever method (KS K 0539), 2) Water-vapor permeability according to KS K 0593, 3) Air permeability by KS K ISO 9237 using Fx 3300(TEXTEST, Swiss).

Antimicrobial Activity Evaluation Evaluated by a quantitative measurement (KS K 0693:2006) using Staphylococcus aureus (S. aureus, ATCC 6538) and Klebsiella pneumoniae (K. pneumoniae, ATCC 4352).

$$R\ (\%) = (B - A)/B \times 100 \quad \text{.....Eq. 1}$$

Where R is the percentage reduction of the bacterium; B is the number of bacterial colonies from an untreated fabric, and A is the number of bacterial colonies from the dyed fabrics.

3. RESULTS & DISCUSSION

Stiffness As shown in Fig.3, stiffness values were not significantly different between specimens.

As for nylon/PU knit, SPM was thought to cause slightly higher stiffness than BIM, which means screen printing on nylon knit might cause much stiffer touch than impregnation method like BIM.

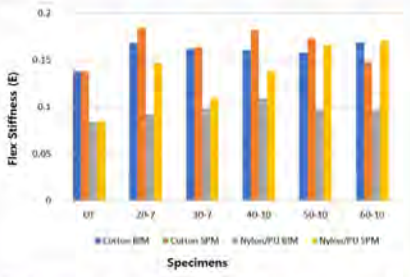

Fig.3 Flex stiffness of microcapsule-treated cotton and nylon/PU knit by BIM & SPM

Water-vapor permeability & Air permeability The values of water-vapor permeability and air permeability of both cotton and nylon means that microcapsule-treated knit might be less permeable to both water-vapor and air owing to microcapsules and binder paste filling up pores in knit structures (Fig.4 & 5).

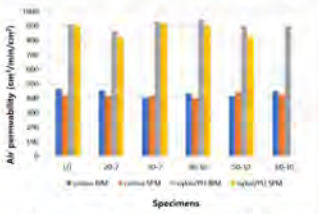

Fig.4 Water-vapor permeability of microcapsule-treated cotton and nylon/PU knit by BIM & SPM

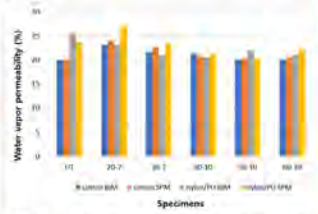

Fig.5 Air permeability of microcapsule-treated cotton and nylon/PU knit by BIM & SPM

Antimicrobial activity From the results for cotton and nylon, it could be concluded that antimicrobial activity of sea buckthorn fruit oil contained in microcapsule might be effective only against S. Aureus on cotton treated by SPM. Screen printing was more effective for cotton jersey to impart excellent microbial activity with microcapsules containing sea buckthorn fruit oil whereas impregnation was acceptable to provide sanitary function to nylon/PU tricot using sea buckthorn microcapsules.

Table 1. Antimicrobial activity of microcapsule-treated cotton knit depending on laundry repetitions

Laundry repetitions	Bacterial reduction rate (%)			
	BIM		SPM	
	Staphylococcus aureus	*Klebsiella pneumoniae*	*Staphylococcus aureus*	*Klebsiella pneumoniae*
0	76.0	0.0	96.0	0.0
1	88.5	0.0	93.3	0.0
5	46.4	0.0	93.1	0.0
10	46.4	0.0	91.5	3.7

4. CONCLUSIONS

- The range of microcapsule concentrations from 20% to 60% owf applied to cotton and nylon/PU respectively was found not to worsen comfort properties such as stiffness, water-vapor permeability, and air permeability of both knits.
- Excellent antimicrobial activities were shown in cotton jersey treated with the microcapsules by screen printing while in nylon/PU tricot by bath immersion.
- From these results, it was concluded that fairly efficient antimicrobial properties could be obtained for cotton and nylon knit by treating with chitosan-arabic microcapsules containing sea buckthorn fruit oil.
- A future study needs to investigate other fiber or fabric types by treating them with microcapsules containing sea buckthorn oil.

ACKNOWLEDGMENTS

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THE SWEDISH SCHOOL OF TEXTILES
UNIVERSITY OF BORÅS

Improved horizontal wicking test for incontinence applications

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INTRODUCTION

To ensure the success of patient support systems and incontinence applications, maintaining an optimal skin microclimate is essential [1, 2]. When choosing materials, accurate evaluations of fabric moisture liquid management (MLM) are vital [3]. Understanding the wicking rate and direction of a fabric directly indicates its ability to effectively spread liquid. In incontinence pads, the wicking direction is highly relevant as the liquid should ideally spread in a way that avoids leakage from the any of the pad's edges [4]. The moisture management tester (MMT) AATCC 195 detects the radial liquid spreading with electrical sensors (Fig. 1) but is not able to distinguish wicking rates in warp and weft direction from one and other, which means that cases of irregular wetting cannot be properly studied (Fig. 2). On the other hand, the horizontal wicking test AATCC 198 lacks guidelines for precise measuring of the dynamic wicking behavior [3]. The MMT does not provide any visualization of the wicking behavior while the horizontal test leaves it entirely up to the observer at the time of assessment.

AIM

The objective of this study was to enhance the AATCC 198 horizontal wicking test by incorporating the detection of liquid transport in multiple directions. This modification aims to optimize healthcare and hygiene supporting products by improving liquid spreading and distribution.

Fig. 1. Illustration of the symmetric placement of sensors in MMT.

Fig. 2. Asymmetric wetting of blue test liquid in fabric.

Fig. 3. Modified AATCC 198 test.

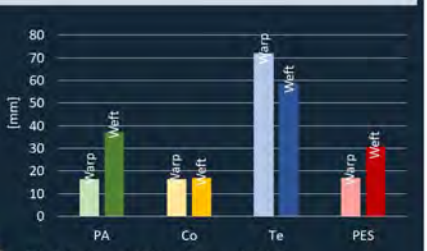

Fig. 4. Horizontal wicking distances in fabrics.

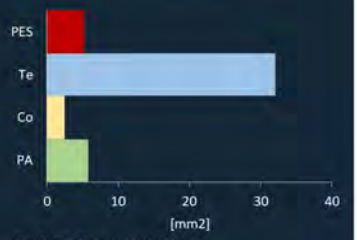

Fig. 5. Wicking areas in fabrics.

METHODOLOGY

Single jersey fabrics of polyamide, cotton, Tencel, and polyester were tested. Prior to testing, all fabrics were washed five times and then cut into specimens measuring 150 x 150 ± 5 mm. The test liquid used was artificial urine, prepared by dissolving 9 g/l of NaCl in deionized water following ISO 3696 standards. The surface tension of the liquid was maintained at (70 ± 2) mN/m. The liquid was supplied by burette, tube, and applied to specimen with a needle at a rate of 0.05 ml/s (Fig.3). A Panasonic Lumix AVCHD Progressive, DMC TZ70 camera was used to record video footage of the experiment. The initial wicking time t0 was determined from when liquid started to spread. From the recorded video, images were captured in Adobe Photoshop for the time intervals: 10, 20, 30, 40, 50, 60 s, 5, and 10 min. In ImageJ, wicking distances in warp and weft direction (Fig. 4) and wicking areas (Fig. 5) were measured from the captures. From the time intervals and distances, wicking rates could be determined (Fig. 6).

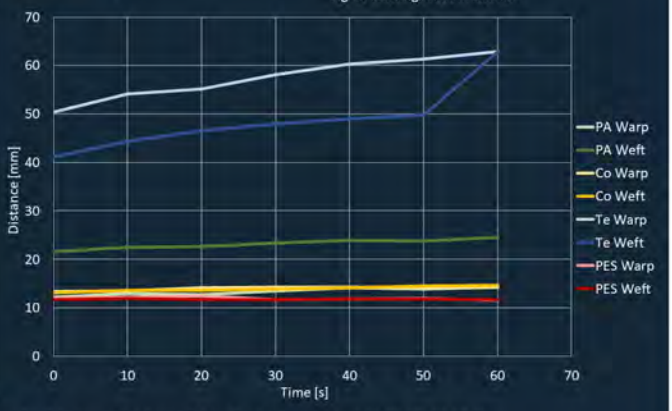

Fig. 6. Horizontal wicking in fabrics for the time intervals 10, 20, 30, 40, 50, 60 s.

CONCLUSIONS

In this study, we modified the AATCC 198 test and applied it to test horizontal wicking in knitted fabrics. The developed method with video recording, and image processing tools, gave successful results in detecting wicking areas, rates, and distances in warp and weft direction. The results showed that there were noticeable differences between the warp and weft direction in the fabrics, especially in polyamide, which had greater wicking performance in the weft direction compared to the warp direction. Polyester also showed a higher liquid transport in the weft direction, while Tencel had better transport in the warp direction. Cotton showed no clear variations in wicking. The improved horizontal wicking test, with its resource-efficient approach, can therefore be a valuable tool in optimizing healthcare and hygiene supporting products, particularly in enhancing liquid spreading and distribution.

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PERFORMANCE PROPERTIES OF SWIMWEAR FABRICS PRODUCED FROM POLYESTER AND RECYCLED POLYESTER FIBER

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Introduction

The textile industry is responsible for producing a significant amount of global CO_2 emission, which is the biggest contributor to global warming and climate change. Researchers have focused on reducing greenhouse gas emission by recycling textile materials rather than producing new fibers through circular economy approaches. Using recycled fibers or blending new fibers with recycled fibers is becoming an essential approach to strike a balance between textile quality and sustainability.

In this study, swimwear fabrics made of 100% polyester, and 50% polyester-50% recycled polyester fiber were investigated in terms of their performance properties including color fastness, abrasion resistance, and seam strength. This study will provide a better understanding of the effect of the polyester fiber and recycled polyester fiber combination on the performance/quality properties of swimwear fabrics.

Experimental

Materials

Swimwear fabric samples produced from 100% polyester, and 50% polyester-50% recycled polyester fiber presented in Table 1 were provided from Boyner Büyük Ltd.

Table 1. Technical properties of the fabrics used in this study

Samples		Unit weight (g/m^2)
100% polyester (100%PES)		191.3
50% polyester-50% recycled polyester (50%PES-50%rPES)		139.9

Methods

Color fastness to washing, water, perspiration, rubbing and artificial light were carried out according to the standard of ISO 105-C06:2010 (A2S), ISO 105-E01:2013, ISO 105-E04:2013, ISO 105-X12:2016, and ISO 105 B02:2014, respectively. Washing fastness was conducted using ECE Detergent-B phosphate and sodium perborate with 10 steel balls in Gyrowash device. Color fastness to sea water and chlorinated water (swimming-pool water) were performed according to the standard of ISO 105-E02:2013 and ISO 105-E03:2010, respectively. Color fastness to chlorinated water was tested at 50 mg/L active chlorine concentration.

Abrasion resistance of the swimwear fabric samples was tested under a known pressure fixed at 9 kPa, in accordance with the ISO standard EN ISO 12947-2:2016. Seam strength of the swimwear fabric samples was determined in accordance with ISO 13935-2:2014.

Results and Discussion

Color fastness test results of swimwear fabric samples, including 100%PES and 50% PES-50%rPES are given in Table 2-3. As can be seen in Table 2, swimwear fabric made of 100%PES had good color fastness properties against washing, water, sea water, chlorinated water, acidic and alkaline perspiration, and rubbing with gray scale ratings of 4/5 and 4. Table 3 shows that swimwear fabric made of 50%PES-50%rPES exhibited good color fastness (4 to 4/5) to sea water, chlorinated water, acidic and alkaline perspiration, and artificial light fastness in terms of both color change and staining. It had also good color fastness (4 to 4/5) to washing and water, except for staining on nylon and polyester, where grayscale ratings ranged from 3 to 3/4. Color fastness to dry and wet rubbing fastness of 50%PES-50%rPES samples was found to be fairly good (3/4).

Table 2. Color fastness test results for swimwear fabric made of 100%PES

	Color change	Color staining					
Color fastness to		acetate	cotton	nylon	polyester	acrylic	wool
washing	4/5	4	4/5	4	4/5	4/5	4/5
water	4/5	4	4/5	4	4/5	4/5	4/5
sea water	4/5	4/5	4/5	4/5	4/5	4/5	4/5
chlorinated water	4	-	-	-	-	-	-
acidic perspiration	4/5	4	4/5	4	4/5	4/5	4/5
alkaline perspiration	4/5	4	4/5	4	4/5	4/5	4/5
rubbing	Dry- 4/5 Wet- 4/5	-	-	-	-	-	-
artificial light	3/4	-	-	-	-	-	-

Table 3. Color fastness test results for swimwear fabric made of 50%PES-50%rPES

	Color change	Color staining					
Color fastness to		acetate	cotton	nylon	polyester	acrylic	wool
washing	4/5	4	4/5	3	3/4	4/5	4/5
water	4/5	4/5	4/5	3/4	4/5	4/5	4/5
sea water	4/5	4/5	4/5	4	4/5	4/5	4/5
chlorinated water	4	-	-	-	-	-	-
acidic perspiration	4/5	4/5	4/5	4/5	4/5	4/5	4/5
alkaline perspiration	4/5	4/5	4/5	4	4/5	4/5	4/5
rubbing	Dry- 3/4 Wet- 3/4	-	-	-	-	-	-
artificial light	4	-	-	-	-	-	-

Seam strength along weft direction was found to be 32.9 kg and 26.23 for 100%PES and 50%PES-50%rPES samples, respectively. On the other hand, seam strength along warp direction was 25.7 kg and 32.16 for 100% PES and 50%PES-50%rPES samples, respectively. All these values are in the acceptable range for swimwear fabric, where the seam strength requirement for both weft and warp direction is 12kg.

Conclusion

This study investigates the performance properties swimwear fabric samples made of 100% polyester, and 50% polyester-50% recycled polyester fiber in terms of color fastness, abrasion resistance, and seam strength. This experimental study will promote the use of recycled fiber or recycled fiber combination in swimwear fabric through circular economy approaches.

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THE DURABLE CHITOSAN FINISHING OF COTTON AND COTTON/POLYESTER BLENDED FABRICS

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INTRODUCTION

Chitosan is a naturally occurring biopolymer that can be produced inexpensively. It is an environmentally friendly agent that has good biocompatibility, bioabsorbability, wound healing, hemostatic, anti-infective, antibacterial, non-toxic and adsorptive properties, and is usually used to achieve the antimicrobial properties of textiles. Due to the increasing requirements for the stability of antimicrobial properties over several maintenance cycles, many authors are researching to permanently bind chitosan to the textile substrate. Therefore, the aim of this research was the durability of chitosan finishing of cellulosic textile substrates, cotton and cotton/polyester blended fabric, using maleic acid as binder and sodium hypophosphite monohydrate as catalyst.

EXPERIMENTAL PART

Standard cotton (CO) and cotton/polyester (CO/PES) fabrics from WFK were used in this study. Standard cotton fabric (10A) is defined in ISO 2267:1986. Polyester/cotton fabric (20A) is manufactured by WFK using the description for standard cotton fabric to make both fabrics as similar as possible. The characteristics of the fabrics are as follows: CO - 100% cotton; CO/PES - 65% polyester and 35% cotton; weight 170 g/m^2; yarn count of warp and weft 27/27 cm^{-1} and linear density 295 dtex, canvas embroidery.

The chitosan of particle diameter range of 1 to 0.5 μm was used. It was purchased from Mathani Chitosan Pvt. Ltd. and provided by Tricomed SA. Chitosan molecular weight (Mn) was 80 and the degree of deacetylation (DDA) 90. Maleic acid (MA) was purchased from Scharlau, Sodium hypophosphite monohydrate (SHP) from Sigma-Aldrich, NF-9 (nonionic surfactant with 9 ethylene oxide groups) from Kemo.

Fabrics were aged for 20h in the bath containing 15 g/l chitosan, 15 g/l MA, 10 g/l SHP and 2 g/l NF-9. After that, the fabrics were treated in microwave oven for 5 min at 80 W, followed by pad-dry-cure method. Wet pick-up on padding machine WP was 100%; conductive drying was carried out at 100 °C for 2 min and thermocondensation at 150 °C for 3 min.

After treatments fabrics were submitted to 10 maintenance cycles. Washing was performed according to ISO 6330:2012 *Textiles — Domestic washing and drying procedures for textile testing* using 20 g/l Reference detergent 3 at 60°C in Wascator FOM71 CLS machine (Electrolux) in accordance with method 6N. Drying was performed in TS130LAB drying machine (Electrolux) according Procedure F. Fabrics were tested before and after treatment, and after 3rd and 10th maintenance cycle. Labels and treatments are listed in Table 1.

Table 1. Labels and treatments of cotton and cotton/polyester fabric samples.

Sample	Treatment
CO	Cotton standard fabric marked WFK 10A
CO_K1	Chitosan treated cotton fabric
CO_K1_3W	Chitosan treated cotton fabric after 3 maintenance cycles
CO_K1_10W	Chitosan treated cotton fabric after 10 maintenance cycles
CO_PES	Cotton/polyester blended fabric marked WFK 20A
CO_PES _K1	Chitosan treated cotton/polyester blended fabric
CO_PES _K1_3W	Chitosan treated cotton/polyester blended fabric after 3 maintenance cycles
CO_PES _K1_10W	Chitosan treated cotton/polyester blended fabric after 10 maintenance cycles

The characterization of surface and chemical composition of cotton (CO) and cotton/polyester (CO/PES) fabrics was performed by Fourier transform infrared (FT-IR) spectroscopy using the attenuated total reflection (ATR) measurement technique (Perkin Elmer, software Spectrum 100, Shelton, CT, USA). Four scans were done for each sample, at the resolution of 4 cm^{-1} between 4000 and 380 cm^{-1}.

Tensile properties were measured according to ISO 13934-1:2013 *Textiles - Tensile properties of fabrics – Part 1: Determination of maximum force and elongation at maximum force using the strip method* on a MesdanLab Strength Tester, distance between clamps 100 mm, bursting speed 100 mm/min and pretension 2 N. From these results mechanical damage was calculated according to ISO 4312:1989 *Surface active agents – Evaluation of laundering - Methods of analysis and tests for unsoiled cotton control cloth.*

$$U_m = \frac{F_0 - F}{F_0} \cdot 100 \quad [\%]$$

U_m is mechanical damage (wear) [%],
F_0 is breaking force of start fabric [N];
F is breaking force of treated and/or washed fabric [N].

For this calculation as start fabric was used standard CO or CO/PES fabric, and secondly each sample was compared to its pair regarding the number of washing cycles.

RESULTS

Physico-chemical characterization was performed after chitosan finishing, and after 3rd and 10th maintenance cycles. The spectral curves obtained by FTIR-ATR analysis of cotton fabric after finishing and maintenance is shown in Figure 1 and of cotton/polyester blended fabric in Figure 2. The results of mechanical properties expressed as force (F) and elongation (ε) at break, and mechanical damage (Um) are collected in Table 2.

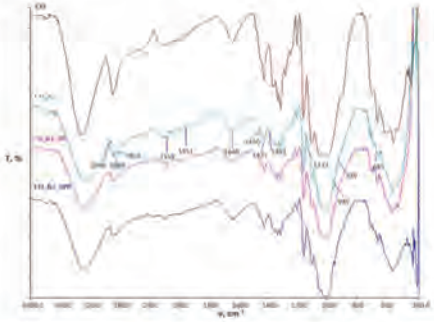

Figure 1. FTIR spectral bands of chitosan finished cotton fabric before and after maintenance cycles compared to untreated fabric

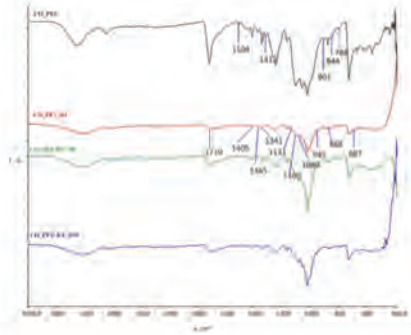

Figure 2. FTIR spectral bands of chitosan finished cotton/polyester blended fabric before and after maintenance cycles compared to untreated fabric

Table 2. Mechanical properties of chitosan finished fabrics after treatment and maintenance cycles.

Sample	F [N]	ε [%]	U_m [%]
CO	726	8.400	-
CO_K1	471	10.900	35.12
CO_K1_3W	480	13.587	33.88
CO_K1_10W	436	12.800	39.94
CO_PES	1044	14.900	-
CO_PES _K1	964	18.300	7.66
CO_PES _K1_3W	937	18.843	10.25
CO_PES _K1_10W	917	18.800	12.26

CONCLUSION

Chitosan is an environmentally friendly and safe substance used to make antimicrobial textiles for medical applications. The binding stability of chitosan to cellulosic materials, cotton and cotton-polyester blended fabrics, by maleic acid was confirmed by FTIR-ATR analysis even after 10 maintenance cycles. The mechanical damage of cotton fabrics is greater than of the cotton/polyester blend because the polyester component contributes to strength and retains it in acidic medium. The work provides good indicators for further research to reduce the mechanical damage of cotton to achieve antimicrobial efficacy.

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HPROTEX

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HRZZ Hrvatska zaklada za znanost

Development of Novel Multilayered Nanocomposite Scaffold for Next-Generation Artificial Nerve Guide Conduit

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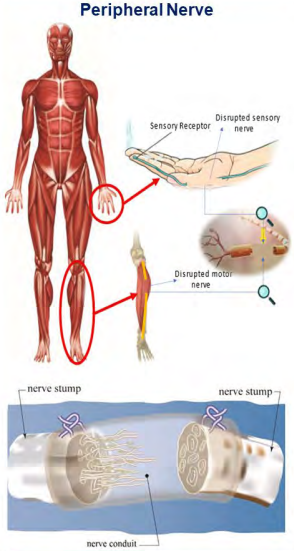
Abstract

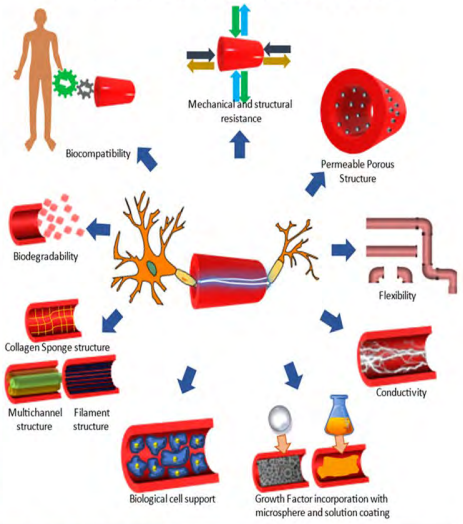
This project will develop a biodegradable, biocompatible, mechanically robust, and electrically conductive multi-layered nanocomposite next-generation artificial nerve guide conduit (NGC) that will potentially provide directional nerve regeneration and promote functional recovery after regeneration. The developed NGC can be connected to wireless electrical stimulation to send the electrical currents in particular directions from proximal to distal nerve stump for better directional nerve growth on a longer nerve gap.

Background of the Research

Peripheral Nerve



Characteristics of Smart Nerve Guide



Novelty of Research

Inner Layer

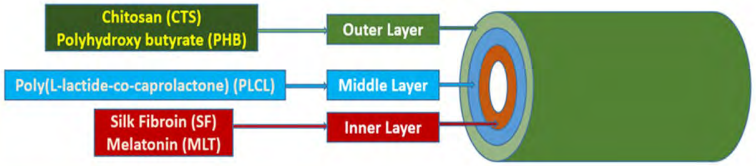
- Highly biocompatible
- Sufficient degradation rate
- Antioxidant and anti-inflammatory
- Electroconductive
- Assist axonal growth in specific direction

Middle Layer

- Mechanically robust

Outer Layer

- Porous
- Sufficient mechanical properties
- Prevent infiltration of unwanted scar tissue
- Inhibit suture-related infections



Methodology

Fabrication of Inner Layer

SF/MLT nanofibrous inner layer by electrospinning technique

Fabrication of Middle Layer

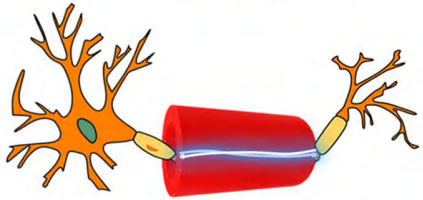
PLCL nanofibrous inner layer by electrospinning technique

Fabrication of Outer Layer

CTS/PHB nanofibrous outer layer by electrospinning technique

Printing Inner Layer Scaffold

Print inner layer with Gold Nanoparticles (GNP) suspensions, in specific pattern using 3D Bioscaffold Printer



Inner and Middle Layer Fabrication

Synthesis of Silk Fibroin Solution from Silkworm Cocoon

Silkworm Cocoon

Silk Fibroin Solution

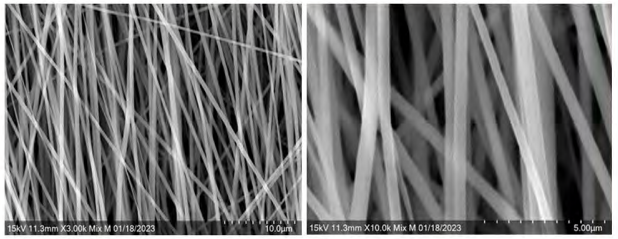
Electrospinning Solution Preparation

- 5% w/v SF mixed with 4% w/v PEO and 0.2% w/v MLT
- Overall composition SF 80%, PEO 15%, MLT 5%

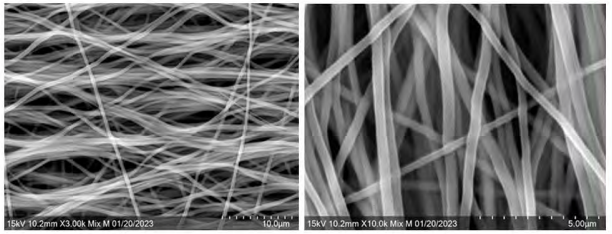
Electrospinning Parameters

Flow Rate (mL/hr)	Voltage (KV)	Distance (cm)	Needle (G)	Collector Speed (rpm)
1.8	12	14	18	1500

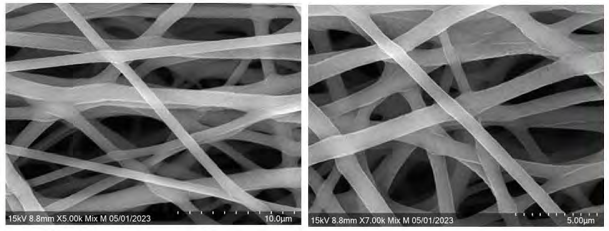
SEM Images of Inner Layer Mat



SEM Images of Inner Layer Mat (After PEO Removal)



SEM Images of PLCL Middle Layer Mat



Key Findings

- SF/MLT inner layer is fabricated with the incorporation of career polymer
- Middle layer fabrication with PLCL that boost electrical conductivity and mechanical strength

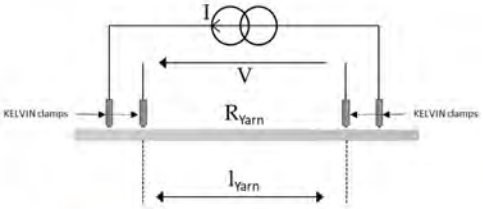
Future Works

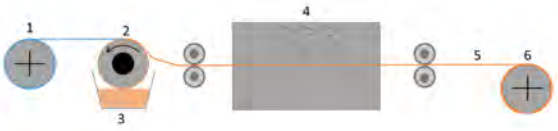
- Fabrication and characterization of outer layer
- Print inner layer with Gold Nanoparticles (GNP) suspensions
- Attach three layers together to fabricate a multilayered nerve guide
- Analyze physiological, mechanical, and biological characteristics

TECHNISCHE UNIVERSITÄT DRESDEN

MOVING SMART TEXTILES TOWARDS SUSTAINABILITY: ENVIRONMENTALLY FRIENDLY PROTECTIVE COATING FOR ELECTRICALLY CONDUCTIVE YARNS

Mareen Warncke, Institute of Textile Machinery and High Performance Material Technology (ITM) and
Centre for Tactile Internet with Human-in-the-Loop (CeTI), TU Dresden





Objective

This poster presents a newly developed non-toxic coating (NTC) to protect the electrically conductive yarns (EC) surface. The NTC consists of an aqueous emulsion with polypropylene wax and oxidized wax. To determine the long-term stability of the coating, the produced yarns undergo comprehensive evaluation using a range of analytical techniques. The aim is to identify the optimal coating by exploring different equipment and parameters. Additionally, various test methods are employed to gauge the durability of the newly developed NTC and ensure its reliability over time.

Methods

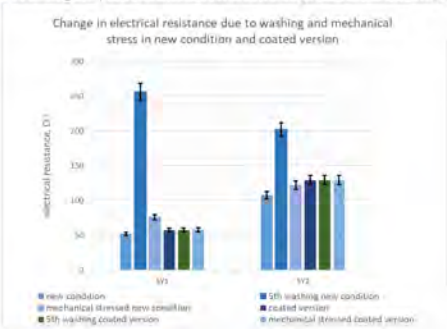
Different electrically conductive yarns are used for developing a non-toxic coating (NTC). The silver plated yarns were coated by coating agents which are based on waxes in water-based emulsions. EC are coated with Base Coater (BC) from Coatema GmbH (Dormagen, Germany). This process is used because with BC, the coating is done without additional roller pressure. The coated yarns were additionally washed and further processed. To characterize the yarn properties before and after the coating

- light microscopy (LM),
- washing processes,
- mechanical resistance tests and
- resistivity measurement

are conducted.

Results

- Non-toxic coating to protect the conductive layer of EC developed



Specific findings include:

- EC were affected by washing and mechanical stress, as evidenced by changes in their electrical resistance
- NTC is a viable solution for improving the durability of conductive and smart textiles
- NTC protects the conductive layer of the yarns during washing and mechanical stress

Literature

1. *WARNCKE, M.; BÖHNKE, P.; GRACOVA, A.; NOCKE, A.; CHERIF, C.: Development of test method for the characterization of electrically conductive yarns for integration in smart textiles: Łódź University of Technology Press, 2022.*
2. *BÖHNKE, P.; WINGER, H.; WIECZOREK, F.; WARNCKE, M.; LÜNEBURG, L. MARIE; KRUPPKE, I.; NOCKE, A.; HÄNTZSCHE, E.; CHERIF, C.: Protective Coating for Electrically Conductive Yarns for the Implementation in Smart Textiles. Solid State Phenomena 333(2022), S.*

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CeTI Centre for Tactile Internet with Human-in-the-Loop

Fabrication Strategies Towards MXene-based Multi-functional Fibres

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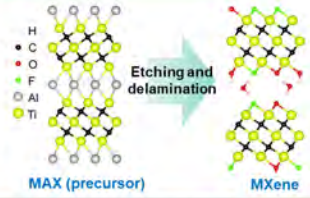
DEAKIN UNIVERSITY

What are MXenes?

New Family of 2D Material
*Unprecedented in terms of;
- ✓ Conductivity
  - ➢ ~24 kS cm^{-1} for $Ti_3C_2T_x$ [1]
- ✓ Capacitance
  - ➢ ~2.8 kF cm^{-3} for $Ti_3C_2T_x$ [2]
- ✓ Aqueous solution stability
  - ➢ Zeta-potential > 40 mV [1,3]

*vs. other 2D materials



Applications

MXene for 'multi-functional' fibres?

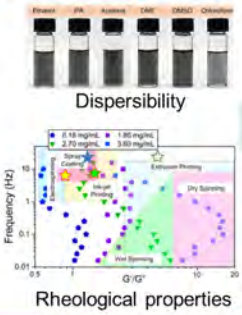
Development of integrated and functional devices

Requirements
- ❑ conducts electricity,
- ❑ harvest and/or store energy
- ❑ sense motion
- ❑ retain user comfort

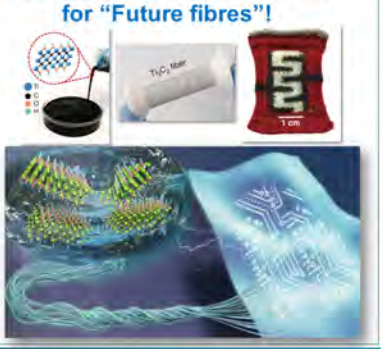
Needs multi-functional (Future) fibres
- ❑ highly conductive
- ❑ energy storing
- ❑ mechanically robust

Examples
- ❑ *conductive polymers (polypyrrole, polyaniline, PEDOT:PSS)*
- ❑ *reduced graphene oxide (rGO)*
- ❑ *colloidal silver*
- ❑ *carbon nanotubes (CNTs)*

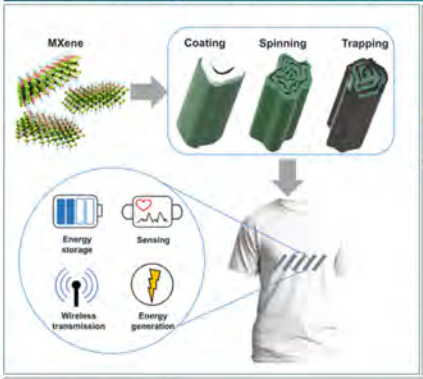
Driven by recent understanding of MXenes



Use MXene as active material for "Future fibres"!



Turning MXene into 'Future Fibres'

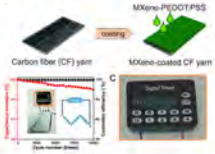


1. Coating free-standing fibres

Binder-free coatings

- ❑ Fibres with H-bonding rich surfaces
- ❑ Simple and scalable
- ❑ Readily knittable fibres for practical applications

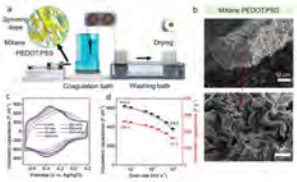
Composite coatings



- ❑ Can be used to functionalise inert fibres
- ❑ More permanent adhesion due to additive

2. Wet-spinning

Aqueous solutions



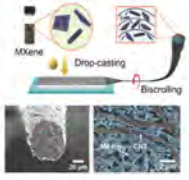
- ❑ MXene+ water-soluble polymers
- ❑ Regenerated cellulose and silk
- ❑ Conductive polymers (e.g., PEDOT:PSS)

Non-aqueous solutions

- ❑ Conductive additive for non-water-soluble polymers (*e.g.*, PAN, PVDF, PCL)
- ❑ Elastomers (e.g., PU)

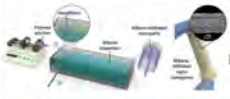
3. Trapping into host galleries

Biscrolling



- ❑ Non-spinnable MXene dispersions trapped into CNT corridors
- ❑ High conductivity and excellent electrochemical performance

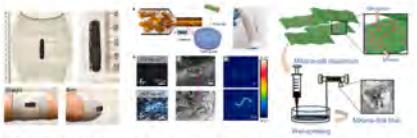
Bath electrospinning



- ❑ Homogeneously trapped MXene within strong fibres
- ❑ e.g., Electrospun Nylon

Outcomes

Conductive yarns of cotton and nylon

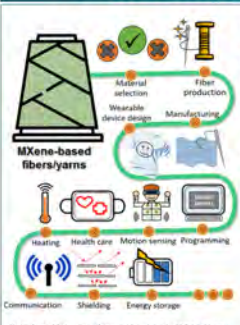


Flexible strain sensors from a non-conductive elastomer

Conductive fibres from pure MXene

Composite fibres from regenerated biomaterials

Future directions



WHAT'S NEXT?: To develop **new material solutions** to bring **functional MXene-based fibre materials** to the marketplace with built-in considerations of **sustainability** along the supply chain.

- ❑ Tailor the surface chemistry
- ❑ Scale up to industrial level
- ❑ Address fundamental trade-offs in properties
- ❑ Standardized device design
- ❑ End-of-life studies

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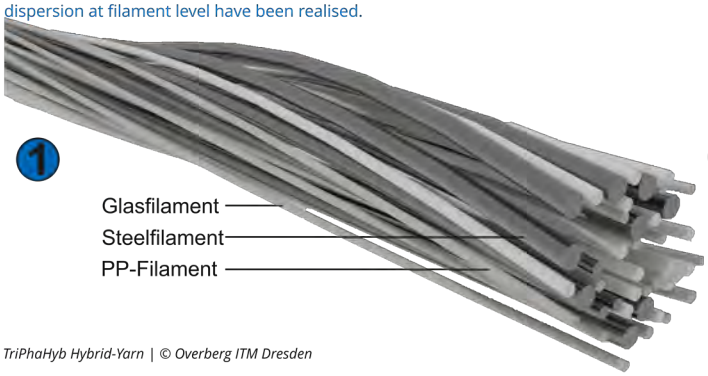
ITM LEADING IN FIBRE & TEXTILE TECHNOLOGY
The Research Institute of University of Excellence

Faculty of Mechanical Science and Engineering Institute of Textile Machinery and High Performance Material Technology

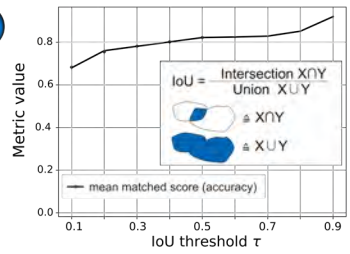
Analyzing Fiber Dispersion in Three-Phase Hybrid Yarns Using KI-based Image Analysis

Objective

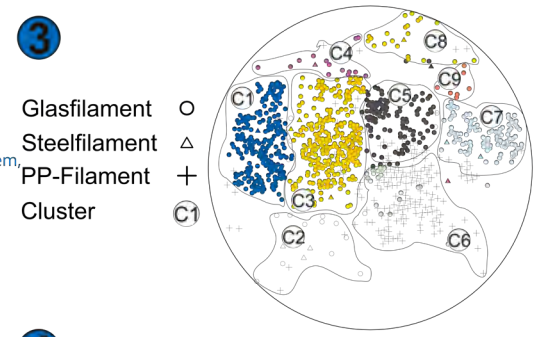
The layered structure of Fiber Metal Laminates (FMLs) can result in delaminations and composite component failure due to insufficient mixing of individual components. To address this issue, Fibre Hybrid Composites dispersed at filament level can be used to enlarge interfaces and achieve a higher degree of mixing between different reinforcing materials. This method improves performance by achieving the largest possible interface and highest degree of dispersion between reinforcement materials. To address this problem, high-performance steel/glass/thermoplastic hybrid yarns (1) with a high degree of dispersion at filament level have been realised.

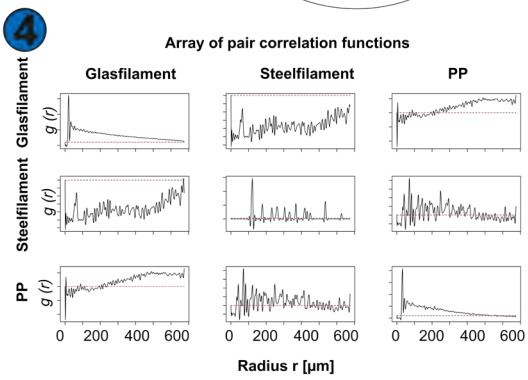


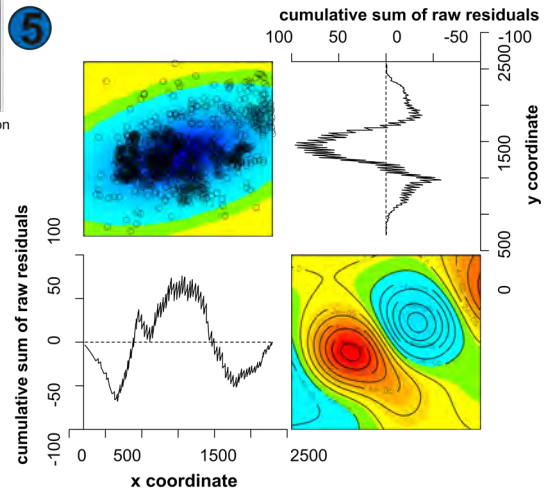
TriPhaHyb Hybrid-Yarn | © Overberg ITM Dresden



Microscopic Image of Hybrid Yarn cross section
Segmentation based on Neural Network







Methods/results

Dispersion in spatial point pattern analysis refers to the degree to which points are distributed relative to one another in a given area. It is a measure of the spatial arrangement of points and can be used to identify patterns or clusters in the data. A dispersion pattern can be described as random, uniform, or clustered, depending on the distance between points. To determine the degree of dispersion it is necessary to know the location of the filaments. To determine these locations, a segmentation based on a Stardist model with U-Net backbone (2) was trained and applied [1]. After determining the locations of filaments in cross-section, a cluster analysis (3) based on Direction Centrality [2] was conducted. The g-pair correlation functions (4) were determined to assess the interaction and influence of filament positions on each other. To further assess the level of dispersion, modelling, simulation, and validation (5) have been carried out [3]. These methods allow for a quantitative analysis of the dispersion level and provide insights into the behavior of the system under different conditions, enabling the optimization of the dispersion process.

[1] Weigert et al.; Star-convex Polyhedra for 3D Object Detection and Segmentation in Microscopy 2020
[2] Dehua Peng et al.; Clustering by measuring local direction centrality for data with heterogeneous density and weak connectivity 2022
[3] Baddeley et al.; Spatial point patterns: methodology and applications with R 2016

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Supported by: Federal Ministry for Economic Affairs and Climate Action, on the basis of a decision by the German Bundestag

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