AACHEN - DRESDEN - DENKENDORF
INTERNATIONAL

TEXTILE

CONFERENCE

AACHEN,
DECEMBER 1-2, 2022

BOOK OF ABSTRACTS

Sustainability in the textile industry

Future of textile production

Textiles for medicine and health care

Smart textiles & fashion

Textiles - past & future

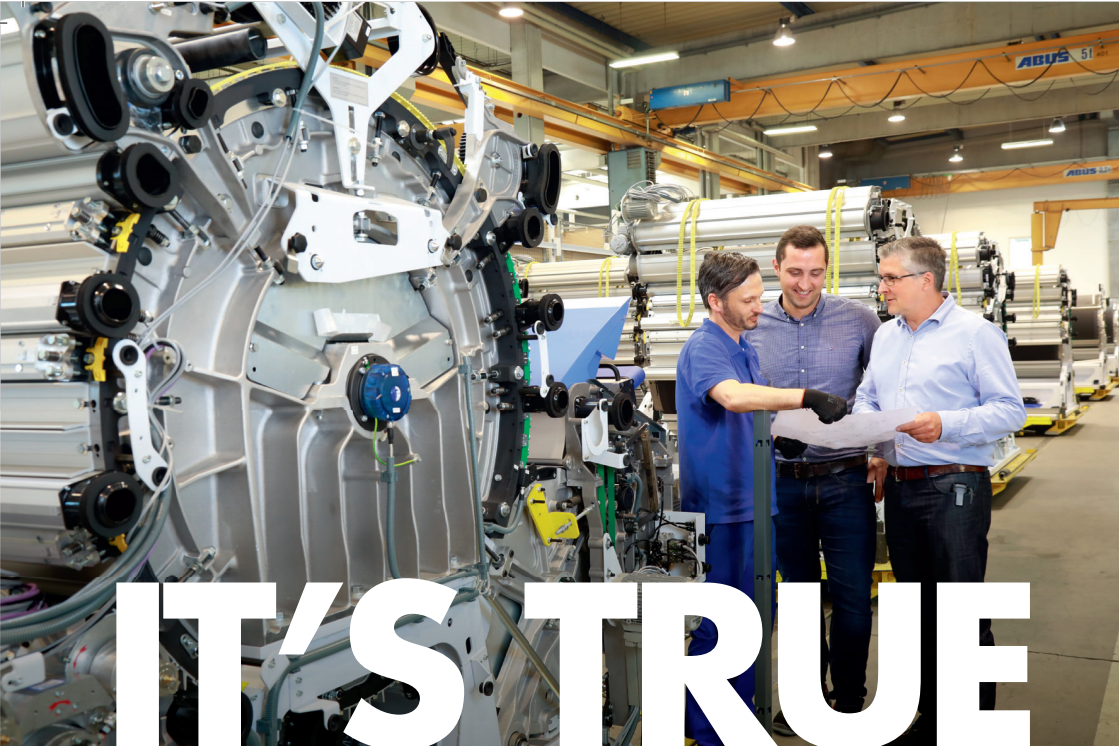
Technology transfer

Textile developments by start-ups

PARTNER COUNTRIES: SWEDEN & FINLAND

www.aachen-dresden-denkendorf.de/itc

AACHEN DRESDEN DENKENDORF
INTERNATIONAL **TEXTILE** CONFERENCE



High-Tech –
so individuell wie unsere Kunden

Erfolg kann viele Gesichter haben – deshalb hören wir bei Trützschler sehr genau zu, welche individuellen Ziele unsere Kunden mit ihrer Baumwoll- oder Chemiefaserverarbeitung erreichen möchten. Passend dazu entwickeln und fertigen wir High-Tech-Produkte, die immer wieder Maßstäbe setzen.

Haben auch Sie offene Ohren und Lust auf innovative Lösungen? Dann besuchen Sie uns auf www.truetzschler.de

TRÜTZSCHLER

AACHEN-DRESDEN-DENKENDORF
International Textile Conference

AACHEN, DECEMBER 1-2, 2022
EUROGRESS AACHEN

Organization
DWI – Leibniz-Institut für Interaktive Materialien e.V.
additc2022@dwi.rwth-aachen.de

Deutsche Institute für Textil- und Faserforschung Denkendorf (DITF)

ITM, Institut für Textilmaschinen und Textile
Hochleistungswerkstofftechnik der TU Dresden

in cooperation with
DTNW, Deutsches Textilforschungszentrum Nord-West e.V., Krefeld
Fachbereich Textil- und Bekleidungstechnik der Hochschule Niederrhein, Mönchengladbach
IPF, Leibniz-Institut für Polymerforschung Dresden e.V.
ITA, Institut für Textiltechnik der RWTH Aachen
ITMC, Institut für Technische und Makromolekulare Chemie der RWTH Aachen
STFI, Sächsisches Textilforschungsinstitut e.V., Chemnitz
TFI, Deutsches Forschungsinstitut für Bodensysteme e.V., Aachen
TITV, Textilforschungsinstitut Thüringen-Vogtland e.V., Greiz

supported by
Forschungskuratorium Textil e.V., Berlin

WWW.AACHEN-DRESDEN-DENKENDORF.DE/ITC

Content
INHALT

A TOUCH OF DORNIER

"Quality creates value" – Savile Row, Via Montenapoleone or Rue du Faubourg Saint-Honoré: Today you will find the finest menswear suit fabrics woven on DORNIER air-jet weaving machines in these exclusive store addresses around the world. It is a perfect example of the close and very successful cooperation between DORNIER and the most prestigeous weavers of their trade.
The DORNIER air-jet weaving machine A1continues to weave on this story of success.

Quality creates value

DORNIER WEAVING

www.lindauerdornier.com

Program committee
PROGRAMMKOMITEE

Thanks are due to the following people for their assistance in compiling the program of the Aachen-Dresden-Denkendorf International Textile Conference 2022:

Bayram Aslan
TFI, Institut für Bodensysteme an der RWTH Aachen e.V.

Michael R. Buchmeiser
DITF, Deutsche Institute für Textil- und Faserforschung Denkendorf

Chokri Cherif
ITM, Institut für Textilmaschinen und Textile Hochleistungswerkstofftechnik der TU Dresden

Johannes Diebel
Forschungskuratorium Textil e.V., Berlin

Peter D. Dornier
Lindauer Dornier GmbH, Lindau

Andreas Fery
IPF, Leibniz-Institut für Polymerforschung Dresden e.V.

Andreas Giessmann
COATEMA Coating Machinery GmbH, Dormagen

Götz T. Gresser
DITF, Deutsche Institute für Textil- und Faserforschung Denkendorf

Thomas Gries
ITA, Institut für Textiltechnik der RWTH Aachen

Jochen Gutmann
DTNW, Deutsches Textilforschungszentrum Nord-West e.V.; Krefeld

Stefan Hecht
DWI, Leibniz-Institut für Interaktive Materialien; Aachen

Andreas Herrmann
DWI, Leibniz-Institut für Interaktive Materialien; Aachen

Heike Illing-Günther
STFI, Sächsisches Textilforschungsinstitut e.V.; Chemnitz

Hubert Jäger
Carbon Composites e.V. Augsburg

Franz-Jürgen Kümpers
Gesamtverband Textil + Mode e.V., Berlin

Bruno Lammers
SAERTEX GmbH & Co. KG. Saerbeck

Ingeborg Neumann
Peppermint Holding GmbH, Berlin

Anke Pfau
Verband der Nord-Ostdeutschen Textil- und Bekleidungsindustrie e.V. (vti), Chemnitz

Michael Pöhlig
Industrieverband Veredlung - Garne - Gewebe - Technische Textilien e.V. (IVGT), Frankfurt am Main

Maike Rabe
Fachbereich Textil- und Bekleidungstechnik der Hochschule Niederrhein; Mönchengladbach

Jochen Schmidt
KARL MAYER Technische Textilien GmbH, Chemnitz

Fabian Schreiber
TITV, Textilforschungsinstitut Thüringen-Vogtland e.V.; Greiz
Gerhard Sperling
Verband der Deutschen Heimtextilien-Industrie e.V., Wuppertal

Markus Stommel
IPF, Leibniz-Institut für Polymerforschung Dresden e.V.

Mathias Ulbricht
DTNW, Deutsches Textilforschungszentrum Nord-West e.V.; Krefeld / Universität Duisburg-Essen

Lutz Vossebein
Fachbereich Textil- und Bekleidungstechnik der Hochschule Niederrhein; Mönchengladbach

Thomas Waldmann
VDMA e.V., Fachverband Textilmaschinen, Frankfurt am Main

Lutz Walter
ETP - The European Technology Platform for the Future of Textiles and Clothing, Brüssel

Jochen Wirsching
Freudenberg SE, Weinheim

WELCOME TO DRESDEN IN 2023

AACHEN DRESDEN DENKENDORF

INTERNATIONAL **TEXTILE** CONFERENCE

Dresden, November 30 - December 01, 2023

- **Polymer Materials and Functionalization**
- **Fiber-reinforced Materials & Composites**
- **Current Developments and Products & Market Strategies & Trends**
- **Future of Textile Production**
- **Technical Textiles: Protective & Functional Textiles**
- **Best Practices: „Transfer – From Idea to Practice“**
- **...**

Program, sponsors, exhibition and online-registration:
https://www.aachen-dresden-denkendorf.de/itc

Venue:
International Congress Center Dresden

Organization:
ITM - Institut für Textilmaschinen und Textile Hochleistungswerkstofftechnik, TU Dresden
with
DWI - Leibniz-Institut für Interaktive Materialien, Aachen
DITF - Deutsche Institute für Textil- und Faserforschung Denkendorf

in co-operation with further research institutes as well as supported by Gesamtverband textil+mode & Forschungskuratorium Textil e.V., Berlin und VDMA, Fachverband Textilmaschinen, Frankfurt/Main

Forschungskuratorium textil

textil+mode

VDMA Textilmaschinen

Gold Sponsors/Gold-Sponsoren

Lindauer DORNIER GmbH, Lindau

DORNIER

Sponsor of the Poster prizes/ Posterpreis-Sponsor

Deutscher Fachverlag GmbH, Frankfurt

Advertisers/Inserenten

Lindauer DORNIER GmbH, Lindau

Trützschler GmbH & Co. KG, Mönchengladbach

Firms and Associations

Avantium

Kompetenzzentrum Textil vernetzt

Physical Electronics GmbH, Feldkirchen

Multi-Plot Europe GmbH

DIENES Apparatebau GmbH, Mühlheim

update texware GmbH, Kulmbach

PPT GmbH & Co. KG, Freiburg

ProCom Automation GmbH, Aachen

Research Institutes

Deutsche Institute für Textil- und Faserforschung Denkendorf (DITF)

Deutsches Textilforschungszentrum Nord-West e. V. (DTNW), Krefeld

DWI – Leibniz-Institut für Interaktive Materialien, Aachen

Hochschule Niederrhein, FB Textil- und Bekleidungstechnik, Mönchengladbach

Institut für Textiltechnik der RWTH Aachen (ITA), Aachen

Institut für Textilmaschinen und Textile Hochleistungswerkstofftechnik der TU Dresden (ITM), Dresden

Sächsisches Textilforschungsinstitut e. V. (STFI), Chemnitz

Thursday, December 1, 2022

9:00 - 10:20	PLENARY SESSION 1 (EUROPASAAL)		
10:20 - 11:00	BREAK		
11:00 - 12:40	PLENARY SESSION 1 (EUROPASAAL) & FASHION SHOW		
12:40 - 14:00	LUNCH BREAK		
14:00 - 15:35	PARALLEL SESSION		
	Future of Textile Production (Europasaal)	Technology Transfer (Brüsselsaal)	Sustainable Textiles (K1)
15:35 - 16:00	BREAK		
16:00 - 17:35	PARALLEL SESSION		
	Future of Textile Production (Europasaal)	Technology Transfer (Brüsselsaal)	Sustainable Textiles (K1)
19:30	CONFERENCE DINNER (TOWN HALL)		

Friday, December 2, 2022

09:00 - 10:30	PLENARY SESSION 2 (EUROPASAAL) START-UP SHORT TALKS		
10:30 - 11:00	BREAK		
11:00 - 12:35	PARALLEL SESSION		
	Future of Textile Production (Europasaal)	Sustainable Textiles (Brüsselsaal)	Textiles for Medicine and Health Care (K1)
12:35 - 13:40	LUNCH BREAK		
13:40 - 15:15	PARALLEL SESSION		
	Future of Textile Production (Europasaal)	Sustainable Textiles (Brüsselsaal)	Textiles - Past & Future (K1)
15:15 - 15:30	BREAK		
15:30 - 16:30	PLENARY SESSION 3 (EUROPASAAL)		
16:30	END OF THE EVENT		

Contents
INHALT

Opening and Greetings

EUROPASAAL, 9:00 - 9:20

Plenary Session 1

EUROPASAAL, 9:20 - 12:40

(Session language: English & German, with simultaneous translation)

9:20 **Dieter Gerten** 36
Potsdam-Institut für Klimafolgenforschung
Planetary Boundaries: Earth's alarming environmental status

09:50 **Ali Harlin, Pirjo Heikkilä**
VTT Technical Research Centre of Finland 37
Development of a textile recycling platform - solving conceptual and technical challenges

10:20 **Coffee Break**

11:00 **Patrick Glöckner** 38
Evonik Operations GmbH
Specialties to enable sustainable plastic applications

11:30 **Giuseppe Gherzi**
Gherzi Textil Organisation AG 39
European textile industry – Quo vadis?

12:00 **Poster short talks**

12:20 **ADD 2022 SPECIAL: Fashion Show ‚Rise!'**
The textile and clothing industry must reinvent itself! At the ADD, the best graduates from the design departments of German universities make the transformation to a sustainable and fair industry visible with an inspiring fashion show. Trendsetting design, technical innovations, sustainability and diversity will be staged in multimedia by the team of Neo.Fashion and Niederrhein University of Applied Sciences.

Future of Textile Production

EUROPASAAL, 14:00 – 15:35

(Session language: English & German, with simultaneous translation)

14:00 **Keynote: Frank Thomas Piller[1], Caja Thimm[2], Kathleen Diener[3]** 44

[1] Institut für Technologie- und Innovationsmanagement, RWTH Aachen

[2] Universität Bonn

[3] IfU e.V. an der RWTH Aachen

Leadership in the Age of Hybrid Intelligence

14:35 **Alexander Ferrein[1], Ingo Kufferath[2], Fatemeh Shahinfar [3], Andrea Altepost[4]** 45

[1] MASKOR Mobile Autonome Systeme und Kognitve Robotik, Fachhochschule Aachen

[2] GKD Gebrüder Kufferath AG, Düren

[3] ifaa Institut für angewandte Arbeitswissenschaft e. V., Düsseldorf

[4] Institut für Textiltechnik der RWTH Aachen University

Holistic AI development for the textile industry of the future

14:55 **Thomas Froese[1], Ruben Kins[2], Frederik Cloppenburg[2], Thomas Gries[2]** 46

[1] atlan-tec Systems GmbH, Mönchengladbach

[2] Institut für Textiltechnik der RWTH Aachen University

Standardized AI methodology improves profitability and sustainability of nonwoven production processes

15:15 **Ralf Müller, Michael Schiffmann** 47

update texware GmbH, Kulmbach

IT 4.0: Vision and Reality in the Textile Industry. How to successfully implement digitization projects in practice

Future of Textile Production

EUROPASAAL, 16:00 – 17:35
(Session language: English & German, with simultaneous translation)

16:00 **Keynote: Verena Thies** 48
Thies GmbH & Co. KG, Coesfeld
Transforming textile processing from various directions- holistic concepts for a more climate-positive future

16:35 **Harald Schwippl** 49
Rieter Machine Works Ltd., Winterthur
The Influence of Tuft and Draw Frame Blending on the Intermediate and End Product

16:55 **Ralf Müller** 50
Trützschler Group SE, Mönchengladbach
My Mill – The digital All-in-One Platform

17:15 **Jörg Kroschinski** 51
Siemens AG, Chemnitz
Condition Monitoring forecast the failour when time for a effective respond

Technology Transfer

BRÜSSELSAAL, 14:00 – 15:35

(Session language: English & German, with simultaneous translation)

14:00 **Keynote: Joerg Kleinalstede** 52

mezzo-forte Stringed Instruments, Werther

The development and market launch of string instruments made of CFRP

together with RWTH Carbon-Quintett

14:35 **change in the conference program: Gerald Hoffmann[1], Cornelia Sennewald[1], Chokri Cherif[1], Manfred Danziger[2], Jens Harhausen[2], Tilmann Leisegang[3]** 53

[1] Institut für Textilmaschinen und Textile Hochleistungswerkstofftechik, TU Dresden

[2] elfolion GmbH

[3] Institut für Experimentelle Physik, Technische Universität Bergakademie Freiberg

Entwicklung folienartiger, ressourceneffizienter gewebebasierter Stromkollektoren aus feinsten Glas-Multifilamentgarnen und Metalldrähten für Elektroden in hochenergie- und -leistungsdichten elektrischen Energiespeichern, z. B. in Lithium-Ionen-Zellen

14:55 **Rainer Bongratz[1], Serhad Cetin[2]** 54

[1] Textech Struve GmbH, Feldkirchen-Westerham

[2] TFI – Institut für Bodensysteme an der RWTH Aachen e. V.

Development of an opto-electronic measuring system for detecting the length input of individual yarns on textile machines using the example of the tufting machine

15:15 **Thomas Mayer-Gall[1], Daniel Fürniß[2] et al.** 55

[1] Deutsches Textilforschungszentrum Nord-West gGmbH, Krefeld

[2] abcr GmbH, Karlsruhe

N-P silane flame retardant from textile to plastic to

Technology Transfer

BRÜSSELSAAL, 16:00 – 17:35
(Session language: English & German, with simultaneous translation)

16:00 **Keynote: Florent Budillon, Marc Bräuner, Kevin Lehmann, Michael Schmid** 56
Admedes GmbH, Pforzheim
Enabling new geometries and faster iteration in designing braided medical devices

16:35 **Karin Ratovo[1], Marcus Krieg[2], Kristina Klinkhammer[1], Isabel Etzel[1], Ellen Bendt[1], Thomas Weide[1], Oliver Heß[1], Thomas Grethe[1], Michael Sturm[2], Boris Mahltig[1]** 57
[1] FTB, Research Institute for Textile and Clothing - Niederrhein University of Applied Sciences, Mönchengladbach
[2] TITK, Thuringian Institute for Textile and Plastics Research Rudolstadt
Preparation of bi-functional textiles from Lyocell with reduced radiation transmission

16:55 **Karsten Gerlach[1], Frank Helbig[2], Maik Berger[3]** 58
[1] TU Chemnitz, Professur Montage- und Handhabungstechnik
[2] SKM Schwergewebekonfektion Moers GmbH, Moers
[3] TU Chemnitz, Professur Montage- und Handhabungstechnik
Concept development of an online filament spreading module

17:15 **Dieter Stellmach[1], Marte Hentschel[2]** 59
[1] Deutsche Institute für Textil- und Faserforschung Denkendorf
[2] Sourcebook GmbH, Berlin
kompakT – A digital co-creation platform for the realisation of sustainable fashion concepts

Sustainable Textiles

K1, 14:00 – 15:35
(Language of the session: English)

14:00 **Keynote: Anna Palmberg, Lena Bischoff** 60
IKEA of Sweden AB, Älmhult, SE
Renewable textile innovations to scalable low-price solutions

14:35 **Pirjo Heikkilä, Taina Kamppuri, Eetta Saarimäki, Marjo Määttänen, Ali Harlin** 61
VTT Technical Research Centre of Finland, Tampere, FI
Technology review of textile recycling

14:55 **Natalia Moreira, Kirsi Niinimäki** 62
Aalto University, Helsinki, FI
Business adaptability in the textile Circular Economy new frontier: a New Cotton Project case study

15:15 **Anna Peterson, Karin Lindqvist, Cecilia Mattsson** 63
RISE Research Institutes of Sweden, Mölndal, SE
Chemical recycling of synthetic textile blends

Sustainable Textiles

K1, 16:00 – 17:35
(Language of the session: English)

16:00 **Keynote: Geza Szilvay** 64
VTT Technical Research Centre of Finland, Helsinki, FI
Growing fungal mycelium for non-woven fabrics

16:35 **Thorsten Bache[1], Daphne Strahl-Schäfer[1], Daniel Pattberg[2], Kristina Klinkhammer[2], Karin Ratovo[2], Hazal Dagdeviren[2], Clara Heil[2], Jana Lewin[2], Boris Mahltig[2], Thomas Weide[2], Ellen Bendt[2]** 65
[1] Bache GmbH, Rheinberg
[2] Research Institue for Textile and Clothing (FTB) at Niederrhein University of Applied Sciences, Mönchengladbach
Hemp knit / HanfKnit - Development of a regionally produced, sustainable zero-waste functional cardigan made of 100% hemp

16:55 **Regina Malgueiro, Inês Pinheiro, Joana Araújo, Bhavin Sorathiya, Sara Fernandes, Bruna Moura** 66
CeNTItvc, Vila Nova de Famalicão, PT
Development of bio-based functional coatings for the functionalization of textiles

17:15 **Ang Zhao[1], Maria Restrepo[1], Stephan Emonds[1,2], Qing Cui[1,2], Angelina Schreiber[1], Barbara Dittrich[2], Tina-Marie Thomas[2], Hannah Roth[1,2], Andreas Herrmann[2], Matthias Wessling[1,2]** 67
[1] AVT.CVT RWTH Aachen University
[2] DWI – Leibniz Institute for Interactive Materials, Aachen
Biofunctional polyelectrolyte complex fiber with controlled morphology using a water-based spinning process

Plenary Session 2

EUROPASAAL, 9:00 - 10:30
(Session language: English & German, with simultaneous translation)

9:00 **Pauline van Dongen** 40
Arnhem, NL
Textiles and wellbeing in everyday life

9:30 **Delia Dumitrescu** 41
University of Borås, Borås, SE
Smart textiles - the approach to sustainability

10:00 **Start-up short talks**

Plenary Session 3

EUROPASAAL, 15:30 - 16:30
(Session language: English & German, with simultaneous translation)

15:30 **Michael Beitelschmidt[1], Chokri Cherif[2]** 42
[1] Institut für Festkörpermechanik der Technischen Universität Dresden
[2] Institut für Textilmaschinen und Textile Hochleistungswerkstoffe der TU Dresden
Modeling and analysis of dynamic yarn behavior for efficient slope of textile machine production management

16:00 **Carlo Centonze, Murray Height** 43
HeiQ, Bad Zurzach, CH
HeiQ Plc: An example of a lean, agile & resilient global SME business model, enabling a steady stream of disruptive innovation in textiles and materials

Future of Textile Production

EUROPASAAL, 11:00 – 12:35
(Session language: English & German, with simultaneous translation)

11:00 **Keynote: Johannes Diebel[1], Robert Peters[2]** 68
[1] Forschungskuratorium Textil e.V., Berlin
[2] Institut für Innovation und Technik (iit), Berlin
Shaping change! Pathway to action for a CO_2-neutral, circular text industry

11:35 **Franz Schütte[1], Leon Reinsch[2], Thomas Kordtokrax[1], Tugsan Vural[1], Andreas Meister[1], Thomas Gries[2]** 69
[1] Penn Textile Solutions GmbH, Paderborn
[2] Institut für Textiltechnik of RWTH Aachen University
Towards Data-driven Setup of the Textile Finishing Process

11:55 **Akitsugu Mori** 70
Murata Machinery Ltd., JP
VORTEX is going to change ‚Common Sense' in Industry

12:15 **Henning Heuer[1], Dirk Hofmann[1], Martin Küttner[1], Jürgen Michauk[1], Martin Oemus[1], Christian Pilz[1], Matthias Pooch[1], Maren Rake[1], Martin Schulze[1], Till Schulze[1]** 71
[1] Fraunhofer-Institut für Keramische Technologien und Systeme IKTS, Dresden
Eddy-current inline inspection of multiaxial carbon fiber plys

Future of Textile Production

EUROPASAAL, 13:40 –15:15

(Session language: English & German, with simultaneous translation)

13:40 **Keynote: Rolf Heimann** 72
HessNatur Stiftung, Berlin
What makes the difference? Applied sustainability in textile and fashion

14:15 **Guy Verrue[1], Ine De Vilder[2], Jan Vincent Jordan[3]**
[1] European Floor Coverings Association, Brussels, BE 73
[2] Centexbel, Ghent, BE
[3] Institut für Textiltechnik of RWTH Aachen University
Circular Sustainable Floor Coverings

14:35 **Claudia Lüling[1], Gözdem Dittel[2]** 74
[1] Frankfurt University of Applied Sciences
[2] Institut für Textiltechnik (ITA) der RWTH Aachen University
6dTEX - Lightweight building components made of 3D textiles

14:55 change in the conference program: **Leon Pauly[1], Lukas Maier[3], Ulrich Nieken[3], Götz T. Gresser[1, 2]** 75
[1] German Institutes of Textile and Fiber Research Denkendorf, (DITF)
[2] Institute for Textile and Fiber Technologies (ITFT), University of Stuttgart
[3] Institute of Chemical Process Engineering (ICVT), University of Stuttgart
Textile porous systems - crossing scales for optimized knitted fabrics

Sustainable Textiles

BRÜSSELSAAL, 11:00 – 12:35
(Language of the session: English)

11:00 **Keynote: Ellinor Niit** 76
imogo AB, Limhamn, SE
How to increase sustainability and flexibility in the textile processing by using innovative new spray technology

11:35 **Nazanin Ansari[1], Hans Ulrich Kohn[2], Thorsten Sick[3]** 77
[1] Schoeller Textil AG, Sevelen, CH
[2] Schoeller Technologies AG, Sevelen, CH
[3] Textilcolor AG, Sevelen, CH
A study to quantify the water, time and energy/CO_2 emission savings in PES dyeing by using Ecodye auxiliaries

11:55 **Evgueni Tarkhanov, André Lehmann** 78
Fraunhofer Institute for Applied Polymer Research IAP, Potsdam
Development of scPLA multifilament yarns for reinforcement of mono-material composites

12:15 **Karsten Pelz[1], Cay-Oliver Bartsch[2], Christopher Albe[3], Alexander Fröhlich[4]** 79
[1] Nomaco GmbH & Co. KG, Rehau
[2] Cobes GmbH, Ettenheim
[3] Sächsisches Textilforschungsinstitut e.V., Chemnitz
[4] TU Chemnitz - Professur für Umformendes Formgeben und Fügen
CarboDesize: Inductive desizing of carbon fibers for homogenization of sizing systems for economic recycling

Sustainable Textiles

BRÜSSELSAAL, 13:40 –15:15
(Language of the session: English)

13:40 **Keynote: Lutz Walter** 80
ETP - The European Technology Platform for the Future of Textiles and Clothing, Brussels, BE
EU Textile Strategy - from Policy Vision to Industrial Practice

14:15 **Nicole Espey** 81
ITA - Institut für Textiltechnik der RWTH Aachen
BioTexFuture - Create the Change

14:35 **Claudio Flores** 82
Mimotype Technologies GmbH, Berlin
Reverse Engineering Cow Sera for Biomanufacturing Elastic Textiles

14:55 **Malte Raube[1], Melina Sachtleben[2], Amrei Becker[2], Naveen Kumar Balakrishnan[3], Fabian Langensiepen[3]** 83
[1] Carl Weiske GmbH & Co. KG, Hof
[2] Institut für Textiltechnik der RWTH Aachen University
[3] Aachen-Maastricht Institute for Biobased Materials e.V., Maastricht, NL
Development of bio-based textile products for four different applications in the project BioBase – challenges and opportunities
Is it possible today to replace petro-based textiles with bio-based ones? A study on four different demonstrators – challenges and opportunities

Textiles for Medicine and Health Care

K1, 11:00 – 12:35
(Language of the session: English)

11:00 **Keynote: Andreas Blaeser** 84
TU Darmstadt
Fiber-reinforced hydrogels and hybrid 3D-bioprinting for load-bearing TE-applications

11:35 **Hongshi Wang[1,2], Andreas Müllen[1]** 85
[1] FEG Textiltechnik mbH, Aachen
[2] RWTH Aachen
In vivo degradation of polypropylene surgical mesh implants

11:55 **Gottfried Betz[1], Julia Danckwerth[2], Bernhard Brunner[3], Christian Dils[4], Kamil Garbacz[5], Irina Leher[6], Stefan Sesselmann[6]** 86
[1] Strick Zella GmbH & Co.KG, Anrode
[2] Kunsthochschule Berlin-Weissensee
[3] Fraunhofer-Institut für Silicatforschung, Würzburg
[4] Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration, Berlin
[5] Technische Universität Berlin
[6] Ostbayerische Technische Hochschule Amberg-Weiden
Knitted e-textiles for Innovative Prevention and Therapy Systems

12:15 **Robert Näger, Juan-Mario Gruber** 87
Institute of Embedded Systems, Zurich University of Applied Sciences, Winterthur, CH
Energy self-sufficient Body Sensor integrated in a Shirt

Textiles - Past & Future

K1, 13:40 –15:15
(Language of the session: English)

13:40 **Keynote: Stefanie Seeberg** 88
GRASSI Museum für Angewandte Kunst Leipzig, Universität zu Köln
New Materials and technical innovations as propulsive power in the History of Textiles

14:15 **Hartmut Kutzke[1], Hana Lukesova[2], Marianne Vedeler[1]** 89
[1] Museum of Cultural History, University of Oslo, NO
[2] University Museum, University of Bergen, NO
TexRec – a project on studying and virtually reconstructing the Viking-age Oseberg tapestries

14:35 **Johanna Banck-Burgess** 90
Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart
The Stone Age routine of knowledge

14:55 change in the conference program: **Tamás Haraszti[1], Koshrow Rahimi[1], Juliana Kurniadi[1], Oliver Rippel[2], Dorit Merhof[2], Andreas Herrmann[1]** 91
[1] DWI - Leibniz Institute for Interactive Materials, Aachen
[2] LfB Institute for Imaging and Computer Vision, RWTH Aachen University
Artificial intelligence for animal hair identification

Posters
POSTER

Dear Collegues, Experts, Friends and Students,

We cordially invite you to join the Aachen-Dresden-Denkendorf International Textile Conference, which will take place on December 1-2, 2022 in Aachen.

The conference sessions addressing the following topics:

- Sustainability in the textile industry
- Future of textile production
- Textiles for medicine and health care
- Smart textiles & fashion
- Textiles - past & future
- Technology transfer (ZIM projects)
- Textile developments by start-ups

After a postponement of the conference in 2020 due to the pandemic and a successful virtual conference in 2021, the ADD-ITC 2022 will take place on-site at Eurogress Aachen. We are extremely looking forward to the personal exchange with you and the special atmosphere of a face-to-face event. We invite you to visit the ADD-ITC as a participant, speaker or with your exhibition booth and to immerse yourself in the fascination of the textile future.

ADD 2022 SPECIAL: Fashion Show ‚Rise!‘

The textile and clothing industry must reinvent itself! At the ADD, the best graduates from the design departments of German universities make the transformation to a sustainable and fair industry visible with an inspiring fashion show. Trendsetting design, technical innovations, sustainability and diversity will be staged in multimedia by the team of Neo.Fashion and Niederrhein University of Applied Sciences.

We are looking forward to meeting you in Aachen!

Prof. Dr. A. Herrmann
for the organizers of
the Aachen area

Prof. Dr. Chokri Cherif
for the organizers of
the Dresden area

Prof. Dr. Götz T. Gresser
for the organizers of
the Stuttgart area

Greetings
GRUSSWORT

Sehr geehrte Kollegen, Experten, Freunde und Studierende,
wir laden Sie herzlich ein zur Aachen-Dresden-Denkendorf International Textile Conference, die am 1. und 2. Dezember 2022 in Aachen stattfinden wird.

Das Programm umfasst Sessions zu den folgenden Themen:
- Nachhaltigkeit in der Textilindustrie
- Zukunft der Textilproduktion
- Textilien für Medizin & Gesundheit
- Smart Textiles & Fashion
- Textiles - Past & Future
- Technologietransfer (ZIM-Projekte im Textilbereich)
- Textile Entwicklungen von Start-ups

Nach einer pandemiebedingten Verschiebung der Konferenz im Jahr 2020 und einer erfolgreichen virtuellen Konferenz im Jahr 2021 wird die ADD-ITC 2022 vor Ort im Eurogress Aachen stattfinden. Wir freuen uns außerordentlich auf den persönlichen Austausch mit Ihnen und die besondere Atmosphäre einer Präsenzveranstaltung. Wir laden Sie ein, die ADD-ITC als Teilnehmende, Vortragende oder mit Ihrem Ausstellungsstand zu besuchen und vor Ort in die Faszination der textilen Zukunft einzutauchen.

ADD 2022 SPECIAL: Fashion Show ‚Rise!'
Die Textil- und Bekleidungswirtschaft muss sich neu erfinden! Auf der ADD machen beste Absolventen der Designfachbereiche deutscher Hochschulen die Transformation zu einer nachhaltigen und fairen Branche mit einer inspirierenden Modenschau sichtbar. Zukunftsweisendes Design, technische Innovationen, Nachhaltigkeit und Diversität werden multimedial durch das Team der Neo.Fashion. und der Hochschule Niederrhein inszeniert.

Wir freuen uns außerordentlich, Sie im Dezember in Aachen begrüßen zu dürfen!

Prof. Dr. A. Herrmann
for the organizers of
the Aachen area

Prof. Dr. Chokri Cherif
for the organizers of
the Dresden area

Prof. Dr. Götz T. Gresser
for the organizers of
the Stuttgart area

Dieter Gerten
Potsdam-Institut für Klimafolgenforschung

Planetary Boundaries: Earth's alarming environmental status

In the current "Anthropocene" epoch, planet Earth is exposed to great stress in many respects as a result of massive human interventions. Consequences are not only the global climate change fueled by continuing greenhouse gas emissions, but also the widespread loss of animal and plant species due to deforestation, the overexploitation of freshwater resources, the pollution of air, soil, land and water ecosystems with fertilizers and chemical waste.

The "Planetary Boundaries" framework – increasingly recognized in academic, policy and business communities – brings together nine major global environmental changes into a unified concept. Precautionary adherence to these boundaries of human interference is intended to ensure that the Earth does not move too far away from its overall state during the past millennia, which enabled a global population of several billion people to maintain a reasonably stable basis for life. However, six of the nine Planetary Boundaries are already transgressed. This increases the risk of serious "course changes" of our planet, especially as several of these environmental changes interact in complex ways.

A major cause of these transgressions is the way we produce our goods – especially our food. That said, there are many opportunities to halt or even reverse the current trends, for example by introducing more sustainable forms of food and fiber production, as well as by alternative consumption patterns. Latest science shows that a technological and cultural turnaround could in principle provide enough food for 10 billion people while respecting the Planetary Boundaries. What could be the role of more sustainable textile production in this transformation …?

Ali Harlin, Pirjo Heikkilä
VTT Technical Research Centre of Finland, Espoo, FI

Development of a textile recycling platform - solving conceptual and technical challenges

Finland base development of textile recycling on two industrial pillars, namely bio- and recycling economy. Building of ecosystem requires lots of trust and common interest. Conceptual and technical challenges of textile recycling platform are many from logistics to shorting and actual converting technologies, but as important are the human factors. Benefitting automation, digital technologies and advanced recognition enable viable industrial solutions. Investments worth of billion euro and almost 17 000 new jobs by 2035 are expected.

Patrick Glöckner
Head of Global Circular Plastics Program,
Evonik Operations GmbH, Marl

Specialties to enable sustainable plastic applications

Evonik helps usually with its specialties to reduce the use of resources by making products more efficient and durable. The Specialty Chemical company bundled all its circular plastics activities in a global program to provide the market solutions that enable the transition from linear to circular plastic value chains. Patrick will give an overview about the role of specialty chemicals to improve process efficiency and quality of the resulting recyclates. Furthermore, the importance of partnerships & ecosystems will be discussed by selected examples.

Giuseppe Gherzi
Gherzi Textil Organisation AG, Zürich, CH

European textile industry – Quo vadis?

Today's textile world is being characterized by brands and retailers looking for alternative non-Chinese sourcing opportunities when their Western markets show signs of recession. On the opposite side, the textile industry is affected by high raw material prices, disruptions of supply chains and raising factor costs. This presentation focusses on the World- as well as specifically on the EU-situation. Following questions will be discussed:

- How strong is the EU27 textile industry ?
- Will capacity come back from Asia (towards EU27) ?
- Is digitalization the salvation of the European textile Industry ?
- What is a possible roadmap for re-launching the EU27 textile industry ?

Pauline van Dongen
Arnhem, NL

Textiles and wellbeing in everyday life

Pauline van Dongen is a designer and researcher. She explores human-garment relationships and alternative fashion (design) practices through the development of smart textiles and clothing.

Her design studio received international recognition with projects such as the Solar Shirt, Phototrope and Issho. With her vision and through a hands-on, 'material aesthetics' approach she emphasizes the value of the physical, sensory experience of clothing and the nurturing qualities of textiles. This is central to her PhD dissertation entitled: A Designer's Material-Aesthetics Reflections on Fashion and Technology with which she received her doctoral degree from Eindhoven University of Technology in 2019. Besides running her own design studio, Pauline is a postdoc researcher at Eindhoven University of Technology, she is co-founder of The Solar Movement and co-initiator of The Solar Biennale, and is a member of the advisory board of the 'ArtEZ Fashion Professorship' and of 'New Order of Fashion'. Pauline received several nominations for her work: she was selected by Forbes for their list of 'Top 50 Women in Tech Europe' (2018) and as 'MIT Innovator under 35 Europe' (2017).

In her lecture, Pauline will make the intimate connection between textiles and well-being and how the relationship with these soft and responsive materials shapes our daily lives. She will draw on recent examples from her own practice, including developing solar textiles for textile architecture applications, using haptic technology to help people breathe better to manage everyday stress, and will share her interest and experimentation with shape-changing textiles.

Delia Dumitrescu
The Swedish School of Textiles University of Borås, Borås, SE

Smart Textiles: The approach to sustainability

Delia Dumitrescu will present the innovation platform in a textile: Smart Textiles at The Science Park Borås. The Smart Textiles at The Science Park Borås and the University of Borås is one of the leading international players in the next generation of innovative fabrics, wearable health care, sustainable textiles and fashion. Science Park Boras at the University of Boras brings together strategic partnerships across academia, business, and policy-makers with over 500 research- and company projects since the start in 2006. Smart Textiles is an established player in the international arena with national and international partnerships.
The lecture will describe the different aspects of the Smart Textile centre that works closely together with researchers, companies and the government in a triple helix structure. The talk will showcase examples from the three focus areas: Sustainable textiles, Smart and Interactive textiles and Industry 4.0 (four point O). Dumitrescu's speech will also address the transition toward the field of textile sustainability since we are facing significant problems related to the textile and fashion industry. In addition, Science Park Borås recently received a government assignment to establish a national platform where Sweden unites for a sustainable textile and fashion industry. Within the national platform, the centre drives activities and educates textile and fashion companies to turn their traditional value chain into a circular economy. Subsequently, examples created in the Big Do Lab will also be presented, where companies and design visionaries are invited to develop inspiring sustainable textile concepts.

Michael Beitelschmidt[1], **Chokri Cherif**[2]
[1] Institut für Festkörpermechanik der Technischen Universität Dresden
[2] Institut für Textilmaschinen und Textile Hochleistungswerkstoffe der TU Dresden

Modeling and analysis of dynamic yarn behavior to efficiently increase the production performance of textile machines

With the aim of resource-efficient and productive manufacturing of textile products, warp knitting is gaining increasing importance as a highly productive but also highly dynamic process for the production of fabrics. Machine speeds of up to 4400 rpm entail an unavoidable inherent dynamic of the yarns caused by the frequency excitation of the stitch formation, oscillations and offset movement of the stitch-forming elements. So far, these inherent yarn dynamics can only be compensated by the elasticity properties of the yarns and maximum production speeds cannot be applied to yarns with low elongation properties (e.g. cotton, cellulose fibers, aramid). Since the yarn demand and the yarn tensile forces in the process are subject to large fluctuations, it is necessary to analyze the warp knitting process in its dynamics at high speeds, and to investigate the interaction between yarns and machine in an integral model. This allows machines and processing operations to be optimized in such a way that efficient, trouble-free operation is possible. The yarn model is of particular importance in this context: It must first represent the longitudinal dynamics with stiffness, damping and relaxation. The transverse dynamics describe the contact with machine elements and the oscillations of free yarn sections. In warp knitting, the yarn-thread contact during the stitch formation process is added. As a particularly innovative approach, elements of multi-body simulation are used for the modeling. The yarn is described as a chain of nonlinear beam elements that can represent all yarn states, including slackness or tight radii at deflections. The function of this modeling approach is illustrated by a list of test models, each representing characteristic situations in the yarn path.

Carlo Centonze, Murray Height
HeiQ, Bad Zurzach, CHE

HeiQ Plc: An example of a lean, agile & resilient global SME business model, enabling a steady stream of disruptive innovation in textiles and materials

HeiQ was built from inception as a lean and agile Network Organization with the objective to enable a SME to conduct Disruptive Materials Innovation. HeiQ's proven R D M innovation process demonstrates a rapid deep innovation methodology allowing to bring innovation from lab to consumer in months.

HeiQ at a glance:

HeiQ Plc is a Swiss, London listed (XLON:HEIQ) purpose-led IP creator for novel materials. HeiQ develops and commercialises technologies that make textiles, surfaces and materials more hygienic, protective, comfortable and resource efficient. Founded in 2005 as a spin-off from the Swiss Federal Institute of Technology Zurich (ETH), HeiQ has strong IPs which are at the forefront of global technology. Active in multiple markets: textiles, carpets, antimicrobial plastics, conductive coatings, medical devices, probiotic household cleaners, personal care and hospital hygiene, HeiQ has created some of the most effective, durable and high-performance technologies in these markets today. A trusted innovation partner for over 300 global brands and with a substantial R&D pipeline, HeiQ has won multiple awards and gained a strong reputation for the ESG and sustainable downstream effect of its innovations. HeiQ research new solutions for partners, delivers scaled up manufacturing from its sites across the world and helps partners with go-to-market launches - aiming for lab to consumer in months.

Frank Thomas Piller[1], Caja Thimm[2], Kathleen Diener[3]
[1] Institut für Technologie- und Innovationsmanagement, RWTH Aachen
[2] Universität Bonn
[3] IfU e.V. an der RWTH Aachen

Leadership in the Age of Hybrid Intelligence

[Following the idea of the talk, this abstract has been generated by machine intelligence using the GPT-3 algorithm. No human intelligence applied.] The talk discusses the concept of hybrid intelligence, which is a form of collaboration between machines and humans. It describes how this concept can be used in companies to help improve productivity how to help humans learn from machines. There is a debate in the intelligence community about the role of humans vs. machines. Machine intelligence can do some things better than humans, such as processing large amounts of data, but is not good at tasks that require common sense or empathy. Augmented intelligence emphasizes the assistive role of machine intelligence, while hybrid intelligence posits that humans and machines are part of a common loop, where they adapt to and collaborate with each other. The talk discusses the implications of increasing machine involvement in organizational decision-making, specifically mentioning two challenges: negative effects on human behavior and flaws in machine decision-making. It argues that, in order for machine intelligence to improve decision-making processes, humans and machines must collaborate. The lecture argues that hybrid intelligence is the most likely scenario for decision making in the future.

Alexander Ferrein[1], Ingo Kufferath[2], Fatemeh Shahinfar [3], Andrea Altepost[4]
[1] MASKOR Mobile Autonome Systeme und Kognitve Robotik, Fachhochschule Aachen
[2] GKD Gebrüder Kufferath AG, Düren
[3] ifaa Institut für angewandte Arbeitswissenschaft e. V., Düsseldorf
[4] Institut für Textiltechnik der RWTH Aachen University

Holistic AI development for the textile industry of the future

The tradition-rich textile industry and future-oriented artificial intelligence; competitive companies and attractive jobs; the Rhenish mining area and its world market leaders -- no contradictions for the competence center of labor research WIRKsam. Here, research institutions together with regional companies and their employees are testing how the textile and related industries can take advantage of the opportunities offered by artificial intelligence and at the same time make work innovative and attractive. The future AI-supported work system is considered here as a socio-technical system in which human-, technology- and organization-related factors are jointly designed.

In three pillars - knowledge: securing & transferring; processes: planning & flexibilizing; and quality: securing & enhancing - nine companies have specified use cases in which AI is to support them. The article describes how the companies first specified their goals for the use of AI using, among other things, an interdisciplinary tool for „business understanding," a system for „data understanding," and a production and work process analysis. The employees are involved with their expertise and their needs.

This approach is then illustrated using the example of a company that wants to introduce an AI application in quality assurance. Currently, the inspection of the product under consideration is carried out in a first stage by an optical camera. For an acceptable percentage of complaints, all parts categorized as „okay" must be inspected by employees in a second stage. This task is not only monotonous and burdensome, but also ties up too much time of employees who could better use their qualifications in product and process development. To this end, work organization and design goals are also addressed in particular when introducing AI support.

Thomas Froese[1], Ruben Kins[2], Frederik Cloppenburg[2], Thomas Gries[2]
[1] atlan-tec Systems GmbH, Mönchengladbach
[2] Institut für Textiltechnik der RWTH Aachen University

Standardized AI methodology improves profitability and sustainability of nonwoven production processes

Using a nonwoven production process as an example, a standardized approach is shown on how artificial intelligence can be used to improve the profitability and sustainability of processes. The method is based on the guideline VDI3714 and can be applied to all textile processes. An automated machine learning method is used to generate a model from production data that predicts product quality and is used for predictive process control. This prevents quality deviations and reduces the production of rejects. In addition, a non-destructive 100% inspection of the most important quality variables can be performed.

Michael Schiffmann, Ralf Müller
update texware GmbH, Kulmbach

IT 4.0: Vision and Reality in the Textile Industry
How to successfully implement digitization projects in practice

As a provider of software specifically for the textile industry (ERP, MES, BI, EDI), we are directly and significantly involved in the implementation of IT 4.0 together with our customers from the textile and apparel industry.

At the beginning there is always a vision - of automated machine placement, self-learning production planning or nimble warehouse robots.

Which projects, however, have arrived in the harsh reality of textile production?

We take a closer look and compare aspirations and reality. Based on real projects, we use popular IT 4.0 topics to show what implementation in practice can look like in concrete terms. Not just individual lighthouse projects, but digitization for everyone.

Example 1: The vision of bidirectional machine communication.

The Reality: Machines from different decades, different manufacturers, no interfaces.

The Project: Integration of the machinery within a monitoring platform.

Plus further examples with solution approaches.

Verena Thies
Thies GmbH & Co. KG, Coesfeld

Transforming textile processing from various directions- holistic concepts for a more climate-positive future

Great challenge brings great opportunity. Textile processing, a large field with numerous and diverse production steps requires a variety of approaches to drive change. Verena Thies, 5 th generation managing shareholder of textile machine manufacturer Thies GmbH and Co. KG, will highlight technology-based solutions for textile producers, enabling a more climate-positive future. She further promotes a digital and automated design and organization of modern textile factories that counteract the multiple challenges of today and tomorrow- shortage of workers, climate and energy crisis.

Harald Schwippl
Rieter Machine Works Ltd., Winterthur

The Influence of Tuft and Draw Frame Blending on the Intermediate and End Product

Estimates suggest that 45% of the fibers are processed in their pure state. 55% are spun into blended yarns. Blended yarns are dominated by blends of cotton and polyester. Due to the increasing consumption of man-made fibers and the important role of blends, Rieter has conducted a study on the influence of different blending systems on intermediate and end products.

Blending is the process of combining fibers of different raw materials, length, fineness or color to form a yarn, thereby specifically influencing the yarn properties. Blending can take place at different process stages in the spinning process. In the study, it was analyzed what effects it has on the sliver, the yarn and the textile surface, whether the raw material is already blended in the tuft or only on the draw frame. Taking into account the final spinning process and the polyester content, a guideline was developed as to when which blending system is most suitable.

Ralf Müller
Head of R&D Technology
Trützschler Group SE, Mönchengladbach

My Mill – The digital All-in-One Platform

Lack of efficiency, downtimes in mill production and poor maintenance: These are some of the major worries in modern mill management. To face theses challenges, My Mill offers a transparent view of your entire spinning mill at one glance and helps with the digital transformation of the process. The platform enables the users to overcome information silos, discover optimization potential and to plan the resources sensibly.

Trützschler has started the roll out of its digital all-in-one platform to customers worldwide and would like to share not only some details of the platform, but also show some use cases which have led to better transparency, more efficient use of resources and reduction in power consumption for a higher degree of sustainability.

Jörg Kroschinski
Siemens AG, Chemnitz

Condition Monitoring forecast the Failour when time for a effective respond

If a mechanical error is happening in a machine you have different prewarning timers:
When you **see** smoke you have minutes
When you **feel** heat you have hours
When you **hear** noice you have days to weeks
When you use **condition Monitoring** you have month to years.
BEFORE THE DESASTER

So condition Monitoring helps you to order spearparts when you are intended to use, plan the time for exchange, save money von unreasoned mantains when you exchange after a certain time.

While the systems for conditioning monitoring do not cost a arm or leg anymore.

Also the interpretation can easily done by a green, yellow and red lamp. This lamp should be a common symbol on every HMI in the future, like it is time information today.

We can use the “Value Based analyse” to have a reliable and easy way to see the upcoming failture or the “frequency based analyse “ to see the source of your trouble before stopping the machine. The detection can be easily integrated in the existing automation, or in the upcoming digitalisation.

Joerg Kleinalstede
mezzo-forte Stringed Instruments, Werther

Die Entwicklung und Markteinführung von Streichinstrumenten aus CFK

Die Entwicklung von Streichinstrumenten aus Kohlefaser stellt besondere Anforderungen an den Instrumentenbau.

Der traditionelle Geigenbau kann auf ca. 350 Jahre Erfahrung mit dem Material “Holz” zurückblicken. Insbesondere in den letzten Jahrzehnten gab es eine große Anzahl an wissenschaftlichen Untersuchungen, die mit teils sehr aufwändigen Mitteln (CT, Spektrographie, Ultraschall) die physikalischen Zusammenhänge und sehr komplexen Mechanismen der Entstehung des Klangs auf Streichinstrumenten und dessen Co-Faktoren auf den Grund gingen.

Für den Werkstoff CFK liegen derartige Untersuchungen noch nicht vor, so dass Entwickler auf das try-and-error - Prinzip angewiesen sind.

Im Verlauf von 13 Jahren haben wir aber grundlegende Erkenntnisse gewonnen, wie die Klangbildung in Streichinstrumenten aus Kohlefaser funktioniert. Wir wissen nunmehr, was der Musiker von einem neuartgen Streichinstrument erwartet, welche Vorurteile er diesem entgegenbringt und wie man diesen Vorurteilen begegnen kann.

Die Geschichte der Streichinstrumente aus CFK ist kurz und geprägt von einigen Rückschlägen, aber auch von großen Erfolgen.

Die Grenzen dessen, was diese Instrumente zu leisten vermögen , sind bei weitem noch nicht ausgereizt. Unsere zukünftige Aufgabe wird es sein, diese Grenzen immer weiter voranzutreiben und die klanglichen Möglichkeiten von Carbon-Streichinstrumenten zu optimieren.

Des weiteren gilt es, die konservativ geprägte Musiker-Klientel zu überzeugen, sich mit dem neuen Werkstoff auseinanderzusetzen und ihn als gleichwertige Alternative zu akzeptieren. Hier ist auch 13 Jahre nach der Markteinführung noch viel Arbeit zu leisten.

change in the conference program: **Gerald Hoffmann[1], Cornelia Sennewald[1], Chokri Cherif[1], Manfred Danziger[2], Jens Harhausen[2], Tilmann Leisegang[3]**

[1] Institut für Textilmaschinen und Textile Hochleistungswerkstofftechik, TU Dresden

[2] elfolion GmbH

[3] Institut für Experimentelle Physik, Technische Universität Bergakademie Freiberg

Entwicklung folienartiger, ressourceneffizienter gewebebasierter Stromkollektoren aus feinsten Glas-Multifilamentgarnen und Metalldrähten für Elektroden in hochenergie- und -leistungsdichten elektrischen Energiespeichern, z. B. in Lithium-Ionen-Zellen

Unfortunately, we cannot provide an abstract for this lecture.

Rainer Bongratz[1], Serhad Cetin[2]
[1] Textech Struve GmbH, Feldkirchen-Westerham
[2] TFI – Institut für Bodensysteme an der RWTH Aachen e. V.

Development of an opto-electronic measuring system for detecting the length input of individual yarns on textile machines using the example of the tufting machine

Textile production based on yarns is mainly done by interlacing (weaving), looping (knitting) or needling (tufting) of many individual yarns. In all three processes, the quantities required for the yarns cannot be calculated in terms of linear processed running lengths in the longitudinal and transverse directions of the textile surface. The incorporation factor of the yarns is particularly high in the tufting technique, which is used to produce the largest share of textile floor coverings in terms of volume. To be able to calculate an additional yarn requirement, the real yarn consumption must be determined.

By developing and setting up the prototype with opto-electronic sensors and using the tufting machine as an example, it is possible to show additional yarn consumption by adding up the fluctuations within the yarn measurement. Herewith, the actual real yarn demand on a textile machine can be measured. Based on a sample report, the set yarn requirement was compared with the measured yarn requirement. There is a clear increase in yarn demand as the pattern becomes more complex.

With the successful completion of the measuring system, transfer possibilities also arise in other textile production processes, where insufficient knowledge about the exact length entries of individual yarns prevent a satisfactory material disposition (e.g. weaving and knitting technology).

This yarn requirement measurement is to be considered economically, but also ecologically high. Real yarn consumption can save fossil materials. Especially for small and medium-sized companys that produce small production batches, this prototype can make an essential contribution to economic efficiency.

Das Forschungsprojekt ZF 4209904 wurde über die AiF im Rahmen des Zentralen Innovationsprogramms Mittelstand (ZIM) vom Bundesministerium für Wirtschaft und Klimaschutz aufgrund eines Beschlusses des Deutschen Bundestages gefördert.

Thomas Mayer-Gall[1], Valbone Shabani[1], Wael Ali[1], Jochen S. Gutmann[1,3], Christoph Hussal-Raic[3], Daniel Fürniß[3]

[1] Deutsches Textilforschungszentrum Nord-West gGmbH, Krefeld

[2] abcr GmbH, Karlsruhe

[3] Physikalische Chemie, Universität Duisburg-Essen& CENIDE, Essen

FLAMZATION – HALOGENFREIE FLAMMSCHUTZMITTEL NICHT NUR FÜR TEXTIL

Innerhalb des ZIM-Projektes FlamZation wurde der Transfer der Anwendung von phosphor- und stickstoffhaltigen Silan-Flammschutzmittel (N-P-Silane) von dem textilen Anwendungsbereich auf das Thema Extrusion und Spritzguss erweitert. Am DTNW wurde in einem IGF-Projekt eine erfolgreiche und waschbeständige Flammschutzausrüstung für Baumwolle und Baumwoll-Polyester-Mischgewebe entwickelt. In Kooperation mit dem Kunststoffinstitut in Lüdenscheid und der abcr GmbH konnte gezeigt werden, dass diese FSM sich auch für Modifikation von Additiven in der Polymerverarbeitung eignen. Dazu wurden als Additive Holzmehl für WPC, Aluminiumhydroxid für Kabelummantelungen und Glaskugeln für Elektronikgehäuse mit diesen FSM modifiziert. Dabei zeigte sich, dass die Entflammbarkeit mit diesen Materialien reduziert wurde. Als Lieferant und kompetenter Partner für Spezialchemie, unterstützte die abcr GmbH als KMU die Forschungsinstitute durch die Synthese der neuartigen Flammschutzmittel. Im Rahmen des Projektes konnte gezeigt werden, dass sich mit dem gewählte Ansatz die FSM an die spezifischen Anforderungen und Eigenschaften der Polymere und Additive anpassen lassen. Erste Produkte für die Flammschutzmodifikation konnten aus dem Labormaßstab in den Scale-up überführt werden und sind nun kommerziell erhältlich.

Acknowledgements

Das ZIM-Vorhaben FlamZation ZF4139703EB9 wurde im Rahmen des Zentralen Innovationsprogramms Mittelstand vom Bundesministerium für Wirtschaft und Klimaschutz aufgrund eines Beschlusses des Deutschen Bundestages gefördert. Wir danken den genannten Institutionen für die Bereitstellung der finanziellen Mittel.

Florent Budillon, Marc Bräuner, Kevin Lehmann, Michael Schmid,
Admedes GmbH, Pforzheim

Enabling new geometries and faster iteration in designing braided medical devices

Cardiovascular or gastro-intestinal implants such as stents, drainage stents, “baskets” or occluders are braided with nitinol wires and shaped into their final shape. The shape setting of such medical devices is possible due to the shape memory property of the nitinol alloys: it allows braids to be shaped several times. The common braiding method for manufacturing medical devices has many limits for designing the medical devices. A new designing method which allows virtual braiding as well as pushing the limits of the common method will be presented.

For manufacturing the devices, a novel braiding machine concept will also be presented. The machine allows stents to be produced flexibly and quickly at the same time. The current braiding production process is being further developed by applying modified physical principles for controlling the braiding paths and intelligent production equipment. The overall concept is based on the development of a highly flexible switch system. The geometric architecture of the overall system intends a spatial, scalable arrangement of horn gears.

Smaller batch sizes in the production of stents become affordable based on the new designing and braiding technology and can thus contribute to better patient care.

Karin Ratovo[1], Marcus Krieg[2], Kristina Klinkhammer[1], Isabel Etzel[1], Ellen Bendt[1], Thomas Weide[1], Oliver Heß[1], Thomas Grethe[1], Michael Sturm[2], Boris Mahltig[1]
[1] FTB, Research Institute for Textile and Clothing - Niederrhein University of Applied Sciences, Mönchengladbach
[2] TITK, Thuringian Institute for Textile and Plastics Research Rudolstadt

Preparation of bi-functional textiles from Lyocell with reduced radiation transmission

The human skin is permanently exposed to environmental influences. Exposure of chemicals or radiation (ultraviolet (UV) or infrared (IR)), can cause serious damages of the skin. Functionalized clothing reducing the radiation transmission reduces stress on the skin. Additional equipment with vitamins can promote its regeneration. Bi-functional textiles based on Lyocell fibers are currently produced and examined for their protective properties. The embedding of TiO2 particles during the Lyocell process, dyeing with selected dyes, subsequent functionalization or printing with absorbing chemicals lead to the reduction of radiation transmission over a broad spectral range by up to 30%. The optimization of bonding parameters in the knitting process also positively influences the properties. Specific knitting constructions allowed TiO2-containing yarns to be placed on the outside of the garment textiles to reduce radiation transmission, and vitamin-containing yarns on the inside for maintenance. The textiles show high abrasion resistance and good washing properties with low pilling tendency and can be used for sports and leisure wear, as well as for work wear.

At the industrial partners, the practical suitability of the yarns is investigated and various textile samples and clothing products are produced on industrial knitting machines.

In addition, a children‘s collection of textiles with functionalized yarns is designed and currently realized as clothing products.

This IGF-project 21077 BG is funded as part of the program for the promotion of industrial joint research IGF by the Federal Ministry for Economic Affairs and Energy based on a resolution of the German Bundestag.

Karsten Gerlach[1], Frank Helbig[2], Maik Berger[3]
[1] TU Chemnitz, Professur Montage- und Handhabungstechnik
[2] SKM Schwergewebekonfektion Moers GmbH, Moers
[3] TU Chemnitz, Professur Montage- und Handhabungstechnik

Concept development of an online filament spreading module

The substitution of metallic materials with fiber-reinforced plastic components causes a steadily increasing demand for composite pre-products in various industries. The production of multi-layer compounds, especially for customer-specific requirements with regards to the type and order of the layers, is currently subject to strict limits. The existing system for the production of multiaxial laid fabrics for integral structural combination, for example, does not allow free placement of a 0° layer during the online process. Such a layer can only be inserted at the beginning, i.e. on the underside as the first layer or at the end as the top layer. Using the alternative, the adaptive structural combination, preconditioned thermoplastic tapes are processed. However, this technology has some disadvantages as well. Two examples of that being an unavoidable waste as well as the general handling of the cuttings to build up the compounds. In addition, subsequent process steps lose some of their initially high productivity because of the non-textile matrix component. This problem formed the starting point for the ZIM cooperation project „FilAkt“, in which a plant concept for the production of purely textile composite pre-products with freely selectable layer orientation was realized in a continuos process. The article gives an insight into the compound module developed within the project, in particular the plant component for filament spreading. For this purpose special ribbon guides were developed, that are actuated in an oscillating manner. These ribbon guides spread the filament, that is supplied from a coil depot online and fed directly in front of the sewing-point into a surface. This is done by superimposing a swelling tensile force in the ribbons with a pneumatic pressurization in the relief phases. The surface thus formed on the width of the system is immediately merged with the textile matrix component and connected through stitch bonding. This concept of a plant module can now be integrated into the conventional structurally integral manufacturing process and thus allows a freely configurable layer structure in a continuos process.

Dieter Stellmach[1], **Marte Hentschel**[2]
[1] Deutsche Institute für Textil- und Faserforschung, Denkendorf
[2] Sourcebook GmbH, Berlin

kompakT – A digital co-creation platform for the realisation of sustainable fashion concepts

The complexity of the fashion supply chains frequently prevents the implementation of innovative and sustainable fashion concepts. The current challenge of the fashion industry can be characterized by:

- Globalised fashion supply chains for short runs being prone to errors due to complexity, being time-consuming and cost-intensive and of huge environmental load;
- Growing demand for short runs (smaller quantities and shorter delivery times), which require the availability of digital collaboration platforms;
- Higher importance of networking of the partners along the value chain, especially manufacturer and brands;
- Design, development, production and distribution processes are not collaborative and sustainable, which means that considerable innovation potential is lost;
- Creativity, experiential knowledge and competences of producers and suppliers remaining unused, material properties or process diversity not being exploited.

Recognising that the consequences concern not only sustainability aspects but also diversity of production processes and transparency of the fashion industry, Sqetch and DITF are about to implement the kompakT digital co-creation platform that bring together designers with partners in production and brands in the value creation of fashion.

The presentation will detail the kompakT approach, the elements and the targeted implementation as on-line service. This includes in addition to the provision of design and product development services the configuration of product and supply chain scenarios with a simulative preview of the effects on social and environmental impacts.

Anna Palmberg, Lena Bischoff
IKEA of Sweden AB, Älmhult, SE

Renewable Textile innovations to scalable low-price solutions

With IKEA vision to create a better everyday life for the many people, IKEA is moving further towards the 2030 goal to only use renewable and recycled materials while becoming more affordable to the many. This without compromising on our product design principles that IKEA refers to as Democratic Design.

Having a 56% renewable or recycled share for our textile and comfort materials is simply not enough. To achieve the goal, we need to be innovative and work together with scientists, innovators, entrepreneurs and suppliers. At IKEA we find gaps and challenges in our journey ahead, but we also bring learnings with us from our work to implement innovations into industry scale production in for example Man Made Cellulosic and Artificial Down & Feather.

IKEA is a Home Furnishing brand who wants to offer a wide range of well-designed, functional home furnishing products at prices so low that as many as possible can afford them. There are today over 470 IKEA stores in 64 markets.

Pirjo Heikkilä, Taina Kamppuri, Eetta Saarimäki, Marjo Määttänen, Ali Harlin
VTT Technical Research Centre of Finland, Tampere, FI

Technology review of textile recycling

'EU strategy for sustainable and circular textiles' states that the future sustainable textile system will rely on long-lived textile products, which contain recycled fibres and which are recyclable. In circular economy the emphasize should be on prevention of waste and more efficient use and reuse of products, and recycling of materials will be solution when products are no longer reusable. Textile materials can be recycled in fibre level or in fibre raw materials level, and options include, for example, mechanical, thermo-mechanical and chemical processes. While most of the main fibre types can be recycled at least in lab scale, up-scaling of these methods in an economically and environmentally sustainable way is not an easy task. Challenges are raised especially from difficult sourcing and inhomogeneity of textile waste, as well as inherent limitations of recycling methods.

This presentations includes summary on different discarded textile waste and possibilities for their optimal utilization. It reviews current status of technologies for textile waste valorisation and recycling. Main challenges and future prospects for sustainable textile circularity are also discussed.

Natalia Moreira, Kirsi Niinimäki
Aalto University, Helsinki, FI

Business adaptability in the textile Circular Economy new frontier: a New Cotton Project case study

The textile industry has been the cradle of sustainability research as the driving force for the industrial revolution and its connection to the first signs of pollution. With the increased exposure of the industry's ill-doings, producers and consumers have started engaging in awareness campaigns to produce and consume textiles sustainably.

Currently embracing circular economy, and its challenges, the textile loop has acknowledged the importance of post-consumer textile waste as a strong and widely available 'raw material'. The New Cotton Project, an European Union-funded Horizon 2020 project, is being developed as an attempt to create a commercial-scale circular ecosystem grounded on the post-consumer textile collection and sorting, followed by its regeneration as the basis for the production of new cotton-like fibres (Infinna™), eventually being launched for the general public through two garment collections (Adidas and H&M - autumn 2022).

With new policies and the widespread attempts to increase recycling and incorporating zero-waste practices, post-consumer textiles and recycling are currently focus activities within the textile industry, however, in order to ensure the collected post-consumer material is compliant with recycling there are several steps to be followed such as the avoidance of what cradle-to-cradle has called hybridous monters (the mixture of biodegradable and recyclable materials in such a way that the final product is neither recyclable nor compostable).

The oral presentation here proposed will present the experiences gathered on the first half of the New Cotton Project, portraying the changes in textile waste management which could improve the supply chain and its sustainable prospects.

Anna Peterson, Karin Lindqvist, Cecilia Mattsson
RISE Research Institutes of Sweden, Mölndal, SE

Chemical recycling of synthetic textile blends

Each year the average European citizen discards 11 kg of textiles. Textile waste is a large and complex waste stream which currently is recycled to a very low degree, and instead ends up in landfills or is incinerated. The few available recycling methods for textiles does not work well for textile blends, where several types of textile fibers are found in the same garment.

We present a single-solvent, chemical recycling method that allows separation and recycling of synthetic textile blends, focused on blends of polyester, nylon, and elastane. Through this method the synthetic textile can be decomposed into its building blocks. These building blocks may be used as a raw material to produce new textile fibers or platform chemicals, thereby replacing fossil oil. The process design utilizes ethylene glycol as the only solvent, and selective decomposition of the textile constistuents is achieved by careful control of the temperature and addition of a selective catalyst. Nylon is decomposed to high molecular weight fragments, at yields of at least 60%. The recovered nylon may be chain extended and mechanically recycled. Polyester is depolymerized into its monomer bis(2-hydroxyethyl) terephthalate (BHET). Glycolysis of neat polyester display BHET molar yields above 85%, while BHET from mixed garments is recovered at 60-70%. BHET can be re-polymerized into polyester or used as a platform chemical for other applications. Thus, the fossil carbon atoms in textiles can be turned into recycled carbon atoms.

Geza Szilvay
VTT Technical Research Centre of Finland, Helsinki, FI

Growing fungal mycelium for non-woven fabrics

Fungal mycelium is an interesting component for biobased materials due to its structural features and living nature. In this talk I will present an overview of mycelium and mycelium-based leather alternatives. I will also discuss our approach to solve current manufacturing bottle necks.

Thorsten Bache[1], Daphne Strahl-Schäfer[1], Daniel Pattberg[2], Kristina Klinkhammer[2], Karin Ratovo[2], Hazal Dagdeviren[2], Clara Heil[2], Jana Lewin[2], Boris Mahltig[2], Thomas Weide[2], Ellen Bendt[2]

[1] Bache GmbH, Rheinberg

[2] Research Institue for Textile and Clothing (FTB) at Niederrhein University of Applied Sciences, Mönchengladbach

Hemp knit / HanfKnit - Development of a regionally produced, sustainable zero-waste functional cardigan made of 100% hemp

Aim of the project is the development of a sustainable cardigan made of 100% hemp. This combines positive physiological properties of hemp, such as good moisture and temperature management, with comfort properties of a knitted garment.

The textile chain starts with the variation of hemp fiber preparation, for different processes and product applications. A challenge is the yarn production from 100% hemp. Production of yarn blends from natural hemp and Lyohemp® (a regenerated fiber made from harvest waste > hemp straw) for different properties of the final textile products, was already successful. The design process already considers sustainability and focuses on monomaterials, a variety of uses (reversable cardigan) and recyclability of the finished product. The cardigan should be produced zero-waste by fully fashioned or seamless knitting processes. Cutting of individual parts, material loss and time-consuming finishing processes are eliminated. Via a body mapping concept, ergonomically placed functional zones and their properties are to be developed and integrated into the knitting construction, adapted to the various requirements for leisure, work and outdoor use. Plating technique offers another option to optimize function and comfort of the jacket.

Improving the processing of hemp fibres into attractive, sustainable natural products with a regional production chain in Germany thus promotes small and medium-sized companies with high innovation potential in the long term.

In addition, increased hemp cultivation (with low THC content) promotes biodiversity and relieves nitrate-polluted soils.

This project is funded as part of the European Union‘s response to the COVID-19 pandemic, REACT-EU project (EFRE-0802061).

Regina Malgueiro, Inês Pinheiro, Joana Araújo, Bhavin Sorathiya, Sara Fernandes, Bruna Moura
CeNTItvc, Vila Nova de Famalicão, PT

Development of bio-based functional coatings for the functionalization of textiles

The reduction of greenhouse gas emissions and saving of fossil resources are key elements for climate protection and to ensure a more sustainable future. One of the promising approaches to help solve this problem is the biomass sourcing and transformation into new materials that can provide new properties and functionalities required in many sectors, making them suitable for high-volume applications and with a better performance than fossil-based materials, which in turn can increase its acceptance by the industry and end users.

Lately, the increasing concern of the application of synthetic and fossil-based polymers and toxic additives for the functionalization of textiles, is driving scientists to move towards the fabrication of non-toxic, biocompatible, and biodegradable coating formulations. As such, the authors developed functional bio-based coating formulations for application on textiles using more sustainable coating technologies (e.g. spray coating), recurring to polymers and additives from natural sources, in order to obtain textiles with improved functionalities.

These developments were performed in the scope of the Bionanopolys project that intends to strengthen the circularity of nano-enabled bio-based materials in the economy launching and promoting an open innovation test bed to develop innovative bionanocomposites from main feedstocks in Europe and bio-based nanoproducts in relevant sectors and improving technologies and processes in different pilot lines. This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement N° 953206.

Ang Zhao[1], Maria Restrepo[1], Stephan Emonds[1,2], Qing Cui[1,2], Angelina Schreiber[1], Barbara Dittrich[2], Tina-Marie Thomas[2], Hannah Roth[1,2], Andreas Herrmann[2], Matthias Wessling[1,2]

[1] AVT.CVT RWTH Aachen University

[2] DWI – Leibniz Institute for Interactive Materials, Aachen

Biofunctional polyelectrolyte complex fiber with controlled morphology using a water-based spinning process

The production of fibers and textiles with antimicrobial properties requires complex, multi-stage and cost-intensive processes in which conventional fibers and textiles made of polymeric materials are subsequently coated. Moreover, the use of proteins or enzymes for added biofunctionality is not possible due to the high temperatures and the use of organic solvents during the production of the fibers.

A new approach involves an innovative, fully aqueous phase inversion-based wet spinning process using a homogeneous polymer solution consisting of a unique biological component combined with charged synthetic polymers. More specifically, genetically engineered highly charged polypeptides (supercharged polypeptides, SUPs) with tailored fuctional groups provide antimicrobial properties, while synthetic polyelectrolytes form the backbone of the fiber.

This work presents the single-step fabrication of polyelectrolyte complex fibers with integrated biofunctionality. An aqueous solution consisting of polystyrene sulfonate (PSS), polydiallyldimethylammonium chloride (PDADMAC), potassium bromide (KBr), and SUPs is extruded through a nozzle over an airgap and into a water coagulation bath. The reduction in the KBr concentration leads to the coagulation of the fiber. This process forms fibers with a dense outer layer and a porous sub-structure. The charged groups in the backbone of SUPs and their interaction with the charged polyelectrolytes ensure their immobilization and stabilization. Moreover, the lack of organic solvents and high temperatures prevent the denaturation of the SUPs and enables future implementation of other biomolecules such as enzymes and proteins.

Johannes Diebel[1], **Robert Peters**[2]
[1] Forschungskuratorium Textil e.V., Berlin
[2] Institut für Innovation und Technik (iit), Berlin

Shaping change! Pathway to action for a co2-neutral, circular text industry.

The textile industry is facing great challenges. Once again, it must show how capable it is of change. The changeover to a CO2-neutral economy and the establishment of closed cycles are becoming particularly important. What challenges are to be mastered and what paths of action are conceivable? The Forschungskuratorium Textil and the Institute for Innovation and Technology (iit), have dealt intensively with these questions in numerous workshops and together show how this change can be actively shaped.

Franz Schütte[1], Isa Bettermann[2], Leon Reinsch[2], Thomas Kordtokrax[1], Tugsan Vural[1], Andreas Meister[1], Thomas Gries[2]
[1] Penn Textile Solutions GmbH, Paderborn
[2] Institut für Textiltechnik of RWTH Aachen University

Towards Data-driven Setup of the Textile Finishing Process

Inappropriate machine settings in the stenter process for textile finishing lead to quality issues mismatches and deviations of the targeted product properties. Finding suitable machine settings experience-based is a time-consuming and difficult process, that causes wastage and ties up productive machine time.

The aim is include data-driven solutions for the process design and setup in the stenter process and thereby to reduce cognitive load of operators and developers. Additionally, the improvment the overall process quality is targeted as the future of textile production is expected to utilise data on an as yet unknown scale. Firstly, existing data and domain knowledge are selected, restructured and supplemented and secondly, beneficial and realizable data mining techniques and AI models for the decision support are indentified and implemented.

Both practical predictor models, classification models and data-driven insights, as well as the capability of domain experts and SMEs are built to further integrate digital solutions.

Acknowledgment

We would like to thank the Federal Ministry for Economic Affairs and Climate Action for funding the research project within the framework of the Zentralen Innovationsprogramms Mittelstand.

Akitsugu Mori
Murata Machinery Ltd., JP

VORTEX is going to change “Common Sense” in Industry

“Sustainability” is the keyword in all industries. In textile industries, the keyword may be how to minimize the production to reduce the loss, how to realize “small lot with speed”. Vortex can be the answer, by covering the widest range in the yarn count, just changing some parts. Also Vortex can keep the same setting to spin the same count in different materials, like 100% Polyester, 100% Viscose, Cotton Blended. This character fits to the target, small lot with speed.

Specialty like filament core yarn has been recognized slowly. Putting the function, not by blending but by separate supply, may make the process easier. Vortex is proud of higher productivity in such field, too.

In the power consumption, Vortex shows unique character. 550 m/min delivery speed requests almost same energy to run 300 m/min. Normaly higher speed or RPM leads to the power increase, but not in Vortex. These points shall be enough to change the standard in industry.

Furthermore, our data collection system will bring a lot of unique service in the future. From the fact that speed up will bring almost nothing, consultation, like using different fiber will bring more profitability than the difference of the fiber cost, can be done. We also can monitor the temperature and humidity. By the data, we can advise relating to productivity, but if we find Vortex is not sensitive in room condition, we may do the opposite thing saying to be free from severe airconditioning. Let’s change Common Sense!

Henning Heuer[1], Dirk Hofmann[1], Martin Küttner[1], Jürgen Michauk[1], Martin Oemus[1], Christian Pilz[1], Matthias Pooch[1], Maren Rake[1], Martin Schulze[1], Till Schulze[1]

[1] Fraunhofer-Institut für Keramische Technologien und Systeme IKTS, Dresden

Eddy current inline inspection of multiaxial carbon fiber plys

To inspect multiaxial high-performance carbon fiber fabrics (so-called NCF non-crimp fabrics) non-destructively and inline in full production width, currently only optical methods using line scan cameras are employed. Invisible hidden layers cannot be inspected with these methods, which limits the inspection to the upper and lower cover layers.

At Fraunhofer IKTS, a completely new eddy current array system has been developed based on the industry proven IKTS EddyCus® Pro-II eddy current box, which allows the detection and evaluation of hidden carbon fiber layers inside a multiaxial layer structure. Through the modular expansion of array elements, the system enables production widths of up to 101“ to be inspected blind pixel-free, in-line and at production speeds of up to 5 m/s. The system can clearly classify metallic contaminants and sewn-in carbon fiber fluffs in addition to automated gap detection, defect size evaluation and fiber orientation measurement.

In this presentation, a theoretical insight into high-frequency eddy current inspection on carbon fiber components will be given, and the special boundary conditions and challenges of integrating it into an array system meeting industrial requirements will be discussed. The channel alignment on the anisotropic carbon fiber fabric was a particular challenge. New methods had to be developed beyond the known standard alignment procedures for eddy current sensor arrays, which will be discussed in the lecture using a practical example. Furthermore, the developed modular eddy current sensor system will be presented in a virtual laboratory tour.

Rolf Heimann
HessNatur Stiftung, Berlin

What makes the difference? Applied Sustainability in Textile and Fashion

In this presentation, Rolf Heimann sheds light on the influence of a well-planned sustainability approach in the textile industry. First, you will understand the development of the concept of sustainability in history up to the present day. This is followed by the identification of current and necessary paradigm shifts. Relevant focal points along the value chain will be pointed out and formulated. This will lead to an indepth explanation of the matrix representing the “holistic approach”. The “holistic approach” is a unique concept developed by the hessnatur Stiftung and enables companies to create an applied definition of sustainability.

Rolf Heimann will provide a clear overview and transparent guidance on how to create an applied, workable roadmap to sustainability for your company.

Sustainability today is not only about ecology and social standards, but to a large extent also about governance requirements. Therefore it is important to act in a structured and prudent manner so as not to fall into actionism.

Guy Verrue[1], Ine De Vilder[2], Jan Vincent Jordan[3]
[1] European Floor Coverings Association, Brussels, BE
[2] Centexbel, Ghent, BE
[3] Institut für Textiltechnik of RWTH Aachen University

Circular Sustainable Floor Coverings

About 3 billion m2 of floor coverings are produced every year in Europe. According to Mordor Intelligence's 2020 report, carpets account for 34% while laminate and vinyl account for 15% and 10% respectively.

The value chains within the flooring sector are particularly complex and characterized by many challenges.

- Industrial symbiosis with other sectors still largely missing;
- Products often manufactured as a multi-material, solid composite that limits the possibility of separation and recycling
- Products' longevity ranges between a just a few days (events' carpets) to more than 20 years (commercial flooring)
- lack of knowledge about flooring products' content at the end of the value chain

Within this context, CISUFLO aims to set up a systemic action not only by working on novel circular products, but also by dealing with the waste streams generated by the current products in the years to come. CISUFLO products aim to enhance the current offering of sustainable floor coverings, ensuring they meet the same quality and performance standards.

The project will deliver improved sorting, separation & recycling technologies useful also for the current waste streams that are mostly incinerated or landfilled. It will generate policy briefs and recommendations supporting policy-making in the flooring sector. The links with the other sectors, both embedded within the consortium and nurtured through our Transition Support Group, enable to multiply the impact of CISUFLO results beyond the project itself. In this lecture the current state of findings and an outlook on the next steps will be provided.

Claudia Lüling[1], **Gözdem Dittel**[2]
[1] Frankfurt University of Applied Sciences
[2] Institut für Textiltechnik (ITA) der RWTH Aachen University

6dTEX - Lightweight building components made of 3D textiles in combination with 3D printing

6dTEX deals with the synergetic combination of two technologies that have so far been utilized separately: 3D printing processes and 3D textile production for sustainable applications in the building industry. In addition, the choice of the same material groups for both, the printing and the textile material, will also enable the production of single-origin, recyclable components.

The aim is to generate a new type of lightweight construction for the building envelope by optimizing technical 3D textiles in combination with additive 3D printing processes. The printing material is minimized in terms of load bearing requirements and is correspondingly optimized. It is combined with a 3D textile that is also precisely optimized for load transfer in the X, Y and Z axes of the textile geometry. Depending on the requirements and applications, the 3D textile can further be programmed (opaque/ translucent/ Insulating). The interplay of hard printing material and soft textile also promises aesthetically convincing solutions.

The project is designed on an experimental basis. In an iterative process, potentially combinable printing and fiber materials have been catalogued and evaluated. In the next step, orienting experiments with 3D printing on 2D textiles (warp-knitted biaxial fabrics) were undertaken to test the adhesive bond. Based on this, right now textiles are designed with geometries and surface structures that enable the adhesive bond and other functions. This is followed by printing trials on and into the 3D textile with linear and point structures. So far, four application options have already been defined for the final bbuilding demonstrators, two of which are to be realized.

change in the conference program: Leon Pauly[1], Lukas Maier[3], Ulrich Nieken[3], Götz T. Gresser[1, 2]

[1] German Institutes of Textile and Fiber Research Denkendorf, (DITF)

[2] Institute for Textile and Fiber Technologies (ITFT), University of Stuttgart

[3] Institute of Chemical Process Engineering (ICVT), University of Stuttgart

Textile porous systems - crossing scales for optimized knitted fabrics

Quality Control is crucial when it comes to fine and technical knits. Digital Twins are on the one hand common in product development and are on the other hand necessary for mechanical or heat and mass flow simulations. For both purposes the exact geometry of the knitted loop is necessary for following processes. In order to parametrize digital twins of knitted fabrics the minimum of wale and course spacing is necessary. Manual extraction of loop parameters by counting and microscopic measurements is time consuming and little precise. A new method based on python toolbox OpenCV can automatically analyze wale and course spacing of knits. The algorithm is explained and validated on different fabrics. It is easy to adapt to new yarns and gauges than other manual or automatic methods. The developed method shows good agreement with common Fourrier-Transformation-based algorithms and manual measurements perspectively.

Ellinor Niit
imogo AB, Limhamn, SE

How to increase sustainability and flexibility in the textile processing by using innovative new spray technology

Textile dyeing is a huge consumer of water, energy, and chemicals. With a growing environmental conscience, the impact associated to the dyeing process of textiles is too high. Large brands put a lot of pressure on the textile mills to adopt environmentally friendly processes and with increased costs for resources and material there is an urgent need for actions to justify remaining on the market.

The concept was defined at the Swedish School of Textiles in 2016. A team started testing the spray application and in 2018 imogo was founded to realize the idea. Imogo has developed a technology based on a unique combination of precision nozzles and patented high-frequency valves, that dramatically reduces the water consumption in the wet processing. By spraying on the textile, exact amount of liquid that is needed to carry the dyestuff or chemistry exactly where it is needed the discharge almost eliminates from the process.

Due to market potential, fastest implementation, and most beneficial environmental savings focus has initially been cellulosic dyeing but working together with selected partners imogo have seen an increasing need for the technology also into other wet processes in the industry. Practically all steps where some exclusive dye, chemical or functionality must be applied the imogo revolutionary spray technology can be implemented to achieve better flexibility, reproducibility, and savings for the manufacturer, and at same time reducing the environmental impact dramatically.

Nazanin Ansari[1], Hans Ulrich Kohn[2], Thorsten Sick[3]
[1] Schoeller Textil AG, Sevelen, CH
[2] Schoeller Technologies AG, Sevelen, CH
[3] Textilcolor AG, Sevelen, CH

A study to quantify the water, time and energy/CO2 emission savings in PES dyeing by using Ecodye auxiliaries

Nowadays, with the world moving towards more sustainable approaches in the textile industry and European guidelines towards a greener vision for textiles by 2030, efforts have been made to optimize the dyeing process of Polyester (PES) fabrics. Dyeing textiles is one of the most polluting, time- and energy-consuming process steps during textile manufacturing. Ecodye technology already developed by Schoeller Textiles AG is an approach for dyeing of PES yarns and piece goods, saving resources, costs and simultaneously protecting the environment. The key point to the proposed innovation is the “Rapid dyeing procedure”.

The rapid dyeing procedure focuses on accelerating the procedure to save time, energy (simultaneously reducing CO2 emissions), and water consumption; with time being a key factor. The aim was to conduct a proof study case for dyeing PES/EL materials by quantifying the water consumption, time, and energy/CO2 emission savings by using Ecodye auxiliaries in bulk production. In order to reach these goals, a series of lab and bulk trials were conducted to prove the expected savings without negative impact on the dyeing-related product properties e.g., color build-up on the fabric and color fastness.

As convincing results, it could be demonstrated that just by replacing the standard auxiliaries for PES-EL blends by the rapid dyeing procedure (Ecodye) and adjusting the dyeing process, approximately 60 % of water, 34 % of energy and Carbon Dioxide emissions, and 35% of time required have been saved. A major contribution could be made with this technology as an important building block for the textile industry in the most common fiber available (PES). Is has been shown that Ecodye can have a major contribution to meet the environmental goals of a more sustainable textile future.

Evgueni Tarkhanov, André Lehmann
Fraunhofer Institute for Applied Polymer Research IAP, Potsdam

Development of scPLA multifilament yarns for reinforcement of monomaterial composites

In fiber form, stereocomplex (sc)PLA offers high potential in the development of PLA-based products for technical applications. High thermal resilience of the scPLA crystal structure even allows the incorporation of such filament yarns into a PLA matrix to produce innovative self-reinforced monomaterial composites. This could significantly expand the range of applications for PLA-based materials.

The lecture reflects the recent research at Fraunhofer IAP in the field of scPLA fiber development by focusing on the melt spinning process and subsequent posttreatmant. The implemented process and the textile-physical property profile achieved, which is close to the range of technical PET fibers, are of decisive importance for ongoing developments of PLA-based monomaterial composites reinforced by scPLA fibers. These include short fiber reinforced composites (SFRC), UD tapes and organosheets for application in the technical segment.

Karsten Pelz[1], Cay-Oliver Bartsch[2], Christopher Albe[3], Alexander Fröhlich[4]
[1] Nomaco GmbH & Co. KG, Rehau
[2] Cobes GmbH, Ettenheim
[3] Sächsisches Textilforschungsinstitut e.V., Chemnitz
[4] TU Chemnitz - Professur für Umformendes Formgeben und Fügen

CarboDesize: Inductive desizing of carbon fibers for homogenization of sizing systems for economic recycling

As part of the „CarboDesize“ project, a functional and economical method for desizing carbon fibers from the recyclable chain using inductive alternating fields was developed and technologically implemented.
The focus of the development work was placed on the inductive desizing of carbon fibers within the textile production chain, a homogeneous material quality after the textile production chain and a reproducible process design. In this context, a scalable technology demonstrator with a current working width of 500 mm was developed, which in particular can reliably remove sizing systems from inhomogeneous fiber materials from the dry offcuts. This approach is particularly effective in the reprocessing of dry recyclates from clothing for recycling into new textile products such as nonwovens or staple fibers for compounding. Both the short heat input of less than 5 seconds, the low residual sizing content of <0.2 wt.% and a mass throughput of approx. 100 kg/h are major advantages of the development work.

Lutz Walter
ETP - The European Technology Platform for the Future of Textiles and Clothing, Brussels, BE

EU Textile Strategy - from Policy Vision to Industrial Practice

The EU Strategy for Sustainable and Circular Textiles was published in March 2022. It lays out an ambitious vision for a deep transformation of the ways textile products are made, used and taken care of at the end of life in Europe. To realise this transformation a truly systemic change in the textile and clothing sector is needed. Some of these changes will be directly enforced by regulation, others will rather be encouraged by incentives or unsustainable practices discouraged through extra charges or transparency requirements. In whatever form these profound changes will be driven, they will require a firework of innovation in design approaches and tools, in new biobased textile materials and chemistry, in more resource-efficient textile processing, in digitally enabled low-waste reshored manufacturing, in sorting, separation and recycling technologies for textile waste, in databases, tools and platforms to better manage the complex textile supply chain and new business models favouring sustainability in all its forms. European policy makers are aware that these innovation efforts cannot be naturally expected from an SME-dominated industry with limited resources, especially given the very short time frames in which some targets should be reached. Therefore significant public funding for development of innnovative textile materials, processes and technologies is expected for the coming years as part of the EU Textile Transition Pathway, the operational implementation plan for the EU Textile Strategy currently being finalised. The lecture will explain the EU textile strategy objectives, implementation plan and expected EU research and innovation funding opportunities related to it.

Nicole Espey
ITA - Institut für Textiltechnik der RWTH Aachen

BioTexFuture - Create the Change

The Textile Industry is not sustainable yet. Annually, over 120 million tons of textile fibres are being processed worldwide, 73% of those are man-made fibres. Over 90 % of those man-made fibres are created on a petroleum basis. A raw material that causes significant environmental damages as well in the production process, as during the use and in the end-of-life phase of the textile product.

We, at the Institut für Textiltechnik (ITA) of RWTH Aachen University, are convinced that by engaging in ground-breaking research we are able to pave the way for innovation in the textile industry. This research is partly at an early stage today, but will be crucially relevant tomorrow. The production of plastics from crude oil causes a wide range of ecological, social and economic problems. Thus, a fundamental industrial turnaround is needed. BIOTEXFUTURE is an innovation space funded by the German Federal Ministry of Education and Research (BMBF) for a duration of 5 years. Since November 2019, adidas has been co-leading the program in collaboration with ITA. We are collaborating with industrial and scientific partners who share our vision to convert the textile value chain from petroleum-based to bio-based and strive every day to create the change needed in the textile industry.

Claudio Flores
Mimotype Technologies GmbH, Berlin

Reverse Engineering Cow Serosa for Biomanufacturing Elastic Textiles

Textiles have been drivers of technological innovation since the dawn of the industrial age. In the 21st century, the textile industry will play an important role in developing new modes of industrial production following sustainability goals. Within BTF our proposal GOLD is working on natural substrate and materials development. While the demand for synthetic textiles has grown by 30% within the past 13 years, modern textile production consumes large quantities of petrochemicals, heat energy and unsustainably sourced raw materials. We believe that nature offers great inspiration for alternative and highly performative textile solutions. The outermost tissue layer of the cow appendices' serosa is an extremely elastic and tear-resistant natural material based on collagen, the most abundant animal biopolymer. Its common name Goldschlägerhaut derives from earlier usage as extremely thin separating layers in the beating of leaf gold. During World War I Goldschlägerhaut was processed at industrial scale during the fabrication of gas ballonets for combat zeppelins of the German Navy1. Inuit peoples across the Polar Circle have crafted water-repellent gut parkas that kept hunters dry in their kayaks high-up on Arctic waters2. World's greatest tennis legends give testament to the game-changing elastic properties of racquets made from natural cow gut too. Harvesting of Goldschlägerhaut at industrial scale as a by- product from meat production is not desirable anymore for a number of reasons, we plan to reproduce a biomanufactured substrate with similar or even superior properties. This will require the biotechnological production of protein polymers using synthetic biology at ton-range. To this end, we will decode the Goldschlägerhaut's structural make-up through biochemical analysis and RNA sequencing. We see an enormous potential for developing biomaterials based on Goldschlägerhaut which can replace spandex (elastane, i.e. polyether-polyurea copolymers). In 2015 total production for spandex was estimated at over 760 kilo tons and is likely to exceed 1,550 kilo tons by 20233 which translates to roughly 8 Billion $ market volume. The entire market volume for elastomeric materials is close to 100 Billion $. GOLD aims at demonstrating the rapid and cost-efficient development of a novel collagen- derived biomaterial for high-performance and next-gen consumer-oriented fabrics and textiles. We will create a demonstrator based on natural Goldschlägerhaut to communicate the long-term vision of biofabricated textiles4.

Malte Raube[1], Melina Sachtleben[2], Amrei Becker[2], Naveen Kumar Balakrishnan[3], Fabian Langensiepen[3]

[1] Carl Weiske GmbH & Co. KG, Hof

[2] Institut für Textiltechnik der RWTH Aachen University

[3] Aachen-Maastricht Institute for Biobased Materials e.V., Maastricht, NL

Development of bio-based textile products for four different applications in the project BioBase – challenges and opportunities

Is it possible today to replace petro-based textiles with bio-based ones? A study on four different demonstrators – challenges and opportunities

Fibers and textiles are used in the four key textile industries of technical textiles, sports textiles, automotive and interiors. In 2019, global fiber production amounted to more than 110 million tons. Of these, 72% are man-made fibers based on natural or synthetic polymers (plastics). A key problem in the production of man-made fibers based on synthetic polymers is the dependence on fossil raw materials, which are subject to various ecological and, in the long term, economic and political risks due to their finite nature. Polymers based on renewable raw materials represent an alternative.

To establish biobased polymers in the textile industry and to demonstrate their full potential is the aim of the work conducted by the eleven partners of the BioBase project. The cooperation between research institutes and industry partners runs trough the complete textile value chain of the respective products to develop viable biobased alternatives. In the course of the project, industrially produced demonstrators (in four key sectors of the textile industry in Germany: automotive, sportswear, interiors and technical textiles) are being created that will have a lighthouse effect for the German bioeconomy and demonstrate the potential of the biobased polymers available on the market. The midpoint of the project has been reached and first conclusions can be drawn from the trials about the challenges and opportunities of biopolymer selection.

Andreas Blaeser
Institute for BioMedical Printing Technology
TU Darmstadt

Fiber-reinforced hydrogels and hybrid 3D-bioprinting for load-

Hydrogels represent the material of choice for diverse cell biology applications, such as 3D cell culture, tissue engineering or 3D bioprinting. Their high water content and biochemical and microstructural similarity to the native extracellular matrix provide the ideal growth environment for living cells. At the same time, however, most hydrogels have limited mechanical strength and stiffness. The lack of mechanical properties poses an obstacle to the surgical handling of hydrogels (e.g. low suture retention) and the biofabrication of load-bearing tissues (e.g. bone, muscle, or tendon). Another challenge arises from the limited diffusivity in macroscopic 3D hydrogel structures. Despite the high water content, nutrients and respiratory gases can only diffuse into the interior of the hydrogel cultures over a distance of a few hundred micrometers. This makes it difficult to build macroscopic tissue structures on a millimeter scale.

The use of fiber-reinforced hydrogels and hybrid 3D bioprinting can address the two aforementioned weaknesses. The talk will present new and already established approaches, such as the integration of micrometer-sized bulk and hollow fibers, the parallel printing of thermoplastic polymers and hydrogels as well as the use of hydrogel-filled spacer fabrics. Besides applications in the field of regenerative medicine (tissue engineering and medical devices), the presented approaches are also applicable to the field of cellular agriculture (e.g. cultured meat) or biotechnical tools (e.g. biorobotic systems).

Hongshi Wang[1,2], **Andreas Müllen**[1]
[1] FEG Textiltechnik mbH, Aachen
[2] RWTH Aachen

In Vivo Degradation of Polypropylene Surgical Mesh Implants

Mesh implant has been applied in hernia repair, urogynecological and breast reconstruction. Polypropylene (PP) is now the most widely used material for non-resorbable mesh implant. Due to the poor biostability of PP, PP mesh is always combined with various additives like an antioxidant. However, explanted PP mesh is often reported with a degradation phenomenon, which appears as mesh surface cracking and peeling. Although whether PP mesh degrades in vivo is still being debated, attention has been drawn to mesh safety. This study investigated the degradation behaviour of PP mesh and its influence on the long-term local tissue reaction. PP meshes, which were implanted in sheep upto 2 years, show surface cracks becoming wider and deeper over time of implantation under Scanning Eletron Microscope (SEM). Fourier Transform Infrared Spectroscopy (FTIR) illustrates extra chemical functional groups (carbonyl (C=O) and hydroxyl (-OH)) increasing with the time of implantation of the meshes. The degradation of 100 in human pelvic floor impanted PP meshes were classified with a classification method developed by this study. The peri-filamentary tissue inflammatory reaction was analysed by scoring the expression of the most common cell markers for the innate immune reaction including macrophage, pro-inflammatory M1, remodelling M2, lymphocyte and neutrophil. None of these inflammatory cells indicates the usual declining expression with longer time of implantation. An elevated local inflammatory reaction in long-term is suggested to be resulted from mesh degradation. This research demonstrates the in vivo degradation of PP mesh and offers a preliminary view of the potential risk of implanting PP mesh. A material with better bio-stability for mesh implant is required for the long-term comfort and safety of the mesh receiving patients.

Gottfried Betz[1], Julia Danckwerth[2], Bernhard Brunner[3], Christian Dils[4], Kamil Garbacz[5], Irina Leher[6], Stefan Sesselmann[6]
[1] Strick Zella GmbH & Co.KG, Anrode
[2] Kunsthochschule Berlin-Weissensee
[3] Fraunhofer-Institut für Silicatforschung, Würzburg
[4] Fraunhofer-Institut für Zuverlässigkeit und Mikrointegration, Berlin
[5] Technische Universität Berlin
[6] Ostbayerische Technische Hochschule Amberg-Weiden

Knitted e-textiles for Innovative Prevention and Therapy Systems

Sensors integrated into clothing make it possible to prevent and treat diseases. Basic concepts and their prototypical implementation in knitted textiles are explained using two examples from larger collaborative research projects. Intensive movement training often improves the situation of hemiparesis patients. Physiotherapists cannot always accompany the therapy in these situations. Interactive textile-integrated electronic systems can support the therapy. The movements of the patients are recorded by inertial sensors in the knitted textile and transferred to a more or less playful software. Diabetics often suffer from polyneuropathy. They don't feel any pressure points, e.g. in their feet. This can lead to the formation of ulcers. Socks equipped with pressure sensors can indicate such pressure points and issue a corresponding warning.

In these applications, the often conflicting aspects of wearing comfort and therapeutic functionality must be optimized. The yarn concept and design take this into account. Particular challenges lie in the textile wiring and contacting of the electronic components. Different methods are presented and evaluated.

Robert Näger, Juan-Mario Gruber
Institute of Embedded Systems, Zurich University of Applied Sciences, Winterthur, CH

Self-sufficient Body Sensor integrated in a Shirt

Monitoring of bodily functions in sports has become increasingly popular in recent years. The devices used today are battery-powered, such as sports wristbands. The presented project investigates different approaches for energy harvesting in sportswear. In cooperation with the company Mammut Sports Group AG, a shirt was modified as an experimental wearer in such a way that the thermal waste heat of the body is used to operate a sensor system. In addition to technical feasibility, great importance was attached to wearing comfort. The project showed following results:

- The best energy harvesting source of a human body is thermal heat
- Energy balance is good
- Wearing comfort needs to be improved

This project uses thermoelectrical generators (TEG) as a harvesting source in shirts from Mammut Sports Group AG. The temperature difference across the TEGs is defined by the body heat and the ambient temperature. The harvesters are sewed into the shirt using pieces of textiles. Since the output power is highly dependent on the position and the movement of the athlete, a TEG system is developed, where several TEGs are connected serial and parallel. This enhances the power output and increases the robustness against movements or other impacts.

Stefanie Seeberg
GRASSI Museum für Angewandte Kunst Leipzig, Universität zu Köln

New Materials and technical innovations as propulsive power in the History of Textiles

The search for new techniques, applications and materials has shaped textile history for centuries. In the past, textile raw materials such as silk or cotton, which are commonplace to us today, were unusual and precious materials whose extraction and processing were closely guarded secrets, artistic marvels and important economic factors. The search was not only for functional innovations such as stronger and more durable color formulations or new fabric properties. New, sensational design was also always crucial in order to be marketable and exportable. International exchange was already a driving factor for developments and innovations in late antiquity. Over the centuries, decisive impulses for Europe came from the East. Often, expulsion and flight also played an important role - one of the most momentous examples in Europe was the expulsion of the Huguenots from France in the second half of the 17th century.

The surviving historical objects are important sources not only for the exploration of textile history, but also for social and cultural, technological and economic history, as well as for international and global relations and interconnections. The task of the museums is to preserve the historical objects, to make them accessible for research and to communicate their historical significance. Conservation and restoration of the fragile artifacts, which often survived in fragments, changed with new technical possibilities and scientific developments. Problematic treatment methods of the past, pesticides as well as harmful dyes have to be considered when handling them. For the presentation and mediation it is necessary to meet the conservation necessities as well as the very different needs and changing demands of the public. Here, too, new materials and technical innovations are the driving force behind the history of presentation and conservation.

Hartmut Kutzke[1], Hana Lukesova[2], Marianne Vedeler[1]
[1] Museum of Cultural History, University of Oslo, NO
[2] University Museum, University of Bergen, NO

TexRec – a project on studying and virtually reconstructing the Viking-age Oseberg tapestries

In 1904, a burial mound situated at the Oseberg farm, ca 100km southwest of Oslo, was excavated. The burial was dated to the Viking Age. Beside from a well-preserved Viking ship, it contained the skeletons of two women, accompanied by a rich collection of gravegoods. Ceremonial as well as daily life objects give a unique insight into the Viking world.

Amongst the artefacts were numerous textile objects, reaching from simple wool fabrics to precious silk embroideries. A particular interest attract the so-called tapestries. More than hundred fragile fragments, belonging to at least three different art works, show scenes with finely crafted human figures, weapons, animals, carriages and houses, as well as geometric symbols. The fragments constitute a unique source of knowledge about Viking Age design, mythology and textile technology.

Recently, the Museum of Cultural History in Oslo launched the project 'Virtual reconstruction, interpretation and preservation of the textile artifacts from the Oseberg find (TexRec)" to investigate the tapestry fragments, aiming in a virtual reconstruction of the tapestries. A wide range of methods within chemistry, archaeology, computer science, imaging, material science, botany and conservation are applied to answer research questions around the tapestries. We aim also in developing a modern conservation strategy for these vulnerable textiles.

The presentation will give an insight into the ongoing TexRec project, which is one of the most comprehensive research project on a single archaeological textile find.

Johanna Banck-Burgess
Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart

The Stone Age routine of knowledge

Around 6000 years back in human history: on the lakeshores of Lake Constance and the lakes in Upper Swabia, people live in small settlements close to the shore, which had an amazing textile craft at their disposal. More than 2400 textile fragments, including meshes, braids and woven textiles, preserved in the permanently damp settlement layers under oxygen exclusion in the archaeological find layers, are a stroke of luck for prehistoric textile archaeology.

Technical textiles were a part of the everyday life of the settlements. This material is also evidence for a selection process and composition of the raw materials. The textile production technique and purpose of the end product.

A recent joint project THEFBO, that was funded by the Federal Ministry of Education and Research (Germany), focused on the significance of these textiles within the context of "Transition from nomadic hunting and gathering until the formation of permanent agricultural settlements".

The fragment remains in these settlements demonstrate a "routine of knowledge", that created the production of two and three-dimensional objects, which had a completely different relevance in the Stone Age than today, where other raw materials, such as metals or plastics, are available. Woody bast, lime bark and grasses were the main materials required, especially the favoured lime bast, which seems only to have been available in limited supply around the area of these settlements. Cultivated textile fibres, such as fibre flax, were used in the Neolithic period. The necessary competence for preparation and processing of woody bast along with the versatile usage put flax fibre and its importance in the background. The specific use in the manufacture of fishing nets raised questions about the properties of fibre flax and lime bast. Material tests at the Institutes of for Textile and Fibre Research in Denkendorf (Germany) and practical experience provided answers that led to some exciting and unexpected conclusions.

change in the conference program: **Tamás Haraszti[1], Koshrow Rahimi[1], Juliana Kurniadi[1], Oliver Rippel[2], Dorit Merhof[2], Andreas Herrmann[1]**
[1] DWI - Leibniz Institute for Interactive Materials, Aachen
[2] LfB Institute for Imaging and Computer Vision, RWTH Aachen University

Artificial intelligence for animal hair identification

There are several animal hair fibers used in textile industry with various production value spanning about an order of magnitude between sheep wool and cashmere. This price gap and the high demand makes diluting the valuable fibers with cheaper ones attractive though morally questionable business. Control of fiber quality and origin based on scanning electron microscopy images is established as standard (ISO 17751). In our current work we investigate whether computer based image processing can produce a reliable and improved alternative to existing methods.

Merve Turan
Calik Denim Textile Company, 1.OSB 2.Cad. No:6, Malatya, Turkey

P1: Microbubble technology and its usage in denim finishing processes

With the increase in population in recent years, fast consumption habits have directed the garment industry and textile manufacturers to develop a sustainable perspective and act more consciously in this regard.

The production process of denim fabric, which is one of the most preferred fabrics due to being economical and comfortable in the textile industry, requires a lot of resource usage. For this reason, manufacturers act with the awareness of making sustainable and environmentally friendly production.

Microbubble are bubbles smaller than millimeter in diameter but larger than 1 micrometer.

They have widespread applications in industry, life sciences and medicine.

In our study, by using the cavitation principle and microbubble technology, it is aimed to improve water fastness values with effective cleaning in different processes in denim finishing processes, as well as to save time, water and energy.

Funda Çira Sabancı
Calik Denim Textile Company, 1.OSB 2.Cad. No:6, Malatya, Turkey

P2: Determining the environmental impacts of denim fabrics made of cellulosic fibers within the scope of life cycle analysis (lca)

The textile industry is among the three most water consuming industries and is the second largest pollutant that pollutes clean water resources. Clothing made of denim fabrics is widely used all over the world. The chemicals used in the production of denim products, especially in finishing processes and washing, have negative effects on the environment and human health. As a lot of water is consumed in finishing processes that include special visual effects such as dyeing, washing and stone washing, the water footprint of denim production is high. In addition to excess water consumption, the formation of dense pollution wastewater, emissions that cause air pollution in denim production are also produced. In the textile industry, which has an important place for our country, research and application of clean production techniques is essential for sustainable production. Within the scope of this study, first of all, the effects on the environment during the production of denim fabrics made of cellulosic fibers and innovative methods applied to reduce these effects will be discussed. In addition, the results of the studies carried out to determine the current environmental impacts will be shared. In the Çalık Denim facility, which has an annual production capacity of 42 million meters, the determination of the existing environmental effects and the research and application of the methods that can be applied to reduce these effects will both provide economic gain for the enterprise and will set an example for the dissemination of cleaner production techniques in the world.

Ahdi Hadrich[1], Sandro Gennen[1], Xavier Joppin[1], Christin Wittmann[2], Niklas Herrmann[2], Felix Jakob[2], Ulrich Schwaneberg[2,3], Rémi G. Tilkin[4], David De Smet[4],Olivier Jolois[4]
[1]Celabor, Herve (Belgium)
[2]DWI – Leibniz Institute for Interactive Materials, Aachen (Germany)
[3]Institute of Biotechnology, RWTH Aachen University (Germany)
[4]Centexbel, Grâce-Hollogne (Belgium)

P3: Surface functionalization of polyolefins using peptide-based adhesion promotors – polysaccharides coating solutions

Polyolefins (PO) are one of the most widely used commercial polymers. Due to their high physical and chemical resistance as well as excellent mechanical properties, PO are used for the manufacturing of fibers finding applications in the textile and medical sector. Despite their promising properties, there is a growing need for textiles based on PO with additional functionalities, such as antimicrobial properties and moisture-management capabilities. Such properties can be achieved via the application of coating solutions containing additives mixed with petroleum-based adhesion promotors for hydrophobic PO surfaces.

In order to avoid the use of petrochemicals, our research activities have focused on the preparation and application of bio-based coating solutions containing bio-based additives. Moisture-management capabilities of PO fibers will be achieved via the coating of PO with solutions containing hydrophilic cellulose nanofibers (CNF) while PO fibers with antimicrobial properties will be prepared via the coating with solutions containing chitin nanofibers (ChNF) or chitosan. The adhesion of CNF and ChNF on hydrophobic PO surfaces will be ensured via the use of engineered adeshion promoting peptides (anchor peptides). Anchor peptides are a class of peptides that consist of a hydrophobic and hydrophilic part and thereby show excellent affinity to many commonly used plastics, like PE and PP. With the current existing anchor peptides and the versatility of protein modification and conjugation methods we are able to tailor surface properties of polyolefins and develop bio-based coatings containing CNF and ChNF.

Besides the preparation and optimization of bio-based nanomaterials, we will highlight the identification and engineering of anchor peptides for the adhesion of CNF and ChNF to PO.

Rémi G. Tilkin[1], David De Smet[1], Sandro Gennen[2], Ahdi Hadrich[2], Xavier Joppin[2], Christin Wittmann[3], Niklas Herrmann[3], Felix Jakob[3], Ulrich Schwaneberg[3,4], Olivier Jolois[1]
[1]Centexbel, Grâce-Hollogne (Belgium)
[2]Celabor, Herve (Belgium)
[3]DWI – Leibniz Institute for Interactive Materials, Aachen (Germany)
[4]Institute of Biotechnology, RWTH Aachen University (Germany)

P4: Functionalization of polyolefin textiles

Polyolefins (PO) are often used in several industrial applications including building, packaging, and textile industries. Their non-polar and hydrophobic properties are problematic for applications requiring compatibility with polar substrates (e.g. paints, inks). Petroleum-based adhesion promoters have been used to improve the adhesion of coatings on polyolefins. However, these compounds are harmful (REACH evaluation).

Another challenge is the development of PO with additional functionalities, such as antimicrobial properties and moisture-management capabilities. Functionalization of the PO surface is therefore required.

The main goal of this project is the development of bio-additives for the improvement of the adhesion of polar substrates, such as paints and coatings, on PO and for the functionalization of its surface. On the one hand, the adhesion of coatings on PO substrates has been studied via the development and application of achor peptides presenting affinity for PO. On the other hand, hydrophilic cellulose nanofibers have been used for moisture-management capabilities of PO fibers while antimicrobial properties are achieved via the coating of chitin nanofibers or chitosan. Process parameters will be varied to affect the final properties (antimicrobial and moisture-management) of the bio-based nanomaterials.

Ine De Vilder, Stijn Van Vrekhem
Centexbel, Zwijnaarde (Belgium)

P5: Boosting circularity, by removing textile coatings.

To date, many of our industries are based on a linear economic model where raw materials are used to make a product which is discarded as waste after use (‚take-make-waste'). The plastics and textile industries are often given examples of this.

The main problem with many goods is that they are not made from a single material: they are coated or dyed to obtain certain functionalities (e.g. colour, barrier, etc.). These layers hinder the recycling process at end-of-life and, as a result, these objects are usually incinerated or landfilled. To strive for an increase of the recyclable fraction, these layers must be separated from the bulk material. Ideally, the design of multi-layer materials should consider the subsequent separation process.

In the European H2020 project DECOAT research is being done on how to remove these coatings and paints from textile and plastics substrates at end-of-life, and so enabling circularity. A first strategy which is explored is the incorporation of specially designed triggers into the adhesive layers. At end-of-life, these additives are activated, leading to debonding of the coating. The envisaged triggering actions are microwave radiation, heat and moist. Secondly, removal of the coatings can also be achieved via a solvation process, which is also being assessed. This poster presentation will focus on the obtained results on debonding of textile substrates.

Américo Cunha1, Mariana Osório1, Ana Barros1, Ricardo Silva1, Alice Ribeiro1, Adriana Cunha1, Augusta Silva2, Pedro Magalhães3, Carlos Silva3, João Sousa4
[1] CeNTI – Centre for Nanotechnology and Smart Materials, Rua Fernando Mesquita 2 785, 4760-034 V. N. Famalicão, Portugal
[2] CITEVE – Rua Fernando Mesquita 2785, 4760-034 V. N. Famalicão, Portugal
[3] TINTEX – Zona Industrial de Campos - Polo I - Apartado 99 – Campos, 4920-009 V. N. Cerveira, Portugal
[4] DOMINGOS de SOUSA – Rua da Igreja Nova 632, 4835-586 Braga, Portugal

P6: Invisible markers for textile products

STVgoDigital PPS1 aims to support the sustainability and circularity of Textile Industry allowing Portuguese Textile Cluster to deliver to the customer an extended or expanded product, with the addition of the data dimension (product ID). The need for safe and reliable information on the sustainability and/or circularity of textile products, including information on who, where, how, with what and under what conditions the product was manufactured, ensuring greater business ethics in textile and clothing sector.

This project allowed the development of an innovative Textile ID system composed of Coded Markers, Coded and customizable Polymeric Fibers and electronic labels that support the creation of the Sustainable and circular Textile ID 4.0 solution, allowing to track products with a solution invisible to users. These markers can be applied to the textile surface through different applications such as spray-coating and screen-printing or incorporated into the fiber itself, being apparently invisible but changing its color through a certain external impulse. On the other hand, it is also possible to integrate an electronic system as a source of information. All these approaches are being tested to validate its adequation to support the entire product life cycle.

This work was developed in the framework of STVgoDIGITAL project (no 46086), which was co-financed by Portugal 2020, under the Operational Program for Competitiveness and

Internationalization (COMPETE 2020) through the European Regional Development Fund (ERDF).

Young-A Son, Raju Penthala, Si Hyeong Park, Minwoo Han
Department of Advanced Organic Materials Engineering, Chungnam National University, 220 Gung-dong, Yuseong-gu, Daejeon, South Korea

P7: Fluorescent Cationic Coumarin With Rigid Molecular Structures To Enhance Lightstability Functions

In this study, novel type cationic, fluorescent, coumarin compoulds with rigid molecular structures were prepared and characterized by spectrophotometric studies. The photochemical functions (UV radiation) of these compounds were discussed in liquid medium. Compared to that of a commercially available molecule, the prepared dyes displayed improved photostability behaviors in these solvents. A coloration experiment was carried out on modacrylic polymer with these compounds with a traditional cationic coloration method. The coloration results exhibited that all the coumarin molecules showed clear fluorescence effects.

With regards to the luminance factor and photostability characteristics, the designed and prepared dyes can be used in high-visibility purpose, fluorescent function and green-yellow warning end-uses with enhanced lightstability.

Antje Ota[1], Ilona van Zandvoort[2], Karla M. Dussan Rojas[2], André van Zomeren[2], Jaap W. van Hal[2], Frank Hermanutz[1]
[1]German Institutes of Textile and Fiber Research (DITF), Denkendorf, Germany
[2]Biobased and Circular Technologies Group, Netherlands Organisation for Applied Scientific Research TNO, Petten, Netherlands

P8: New feedstock approaches for cellulose filaments production towards a circular economy

The HEREWEAR project aims at the creation of an EU economy for locally-produced circular textiles and clothing made from bio-based resources. As alternative for cotton cellulose filaments made of bio-based waste sources, specifically agricultural and seaweed residues, are investigated.

The HighPerCell® process is a sustainable technology for spinning of man-made cellulosic fibers using ionic liquids as direct solvent and allowing the environmentally friendly spinning of textile cellulose fibres. The process itself is a three-component system: feedstock, ionic liquid and water. There are no further additives for the spinning process needed. No waste water production, mild processing temperatures and a nearly complete solvent recovery are secured. Beside classical feedstocks that are usually used in viscose and lyocell spinning processes such as wood, HPC technology posses a hugh feedstock flexibility and tolerance. Within Herewear project wheat straw was selected as an interesting material due to its high availability and extractive composition. Wheat straw fractionation is performed via pre-extraction mild acetone organosolv (FABIO-LATM process) and alkaline treatment to maximise the recovery of a raw cellulosic pulp, as well as hemicellulosic sugars and high-purity lignin. Unbleached and bleached cellulosic pulp was further processed into textile filaments via the HighPerCell® technology that renders a proof of the HEREWEAR concept viability.

First prototypes developed within the project showed the technical feasibility of the bio-based garments with good properties of the wheat straw cellulose-based textiles.

HEREWEAR is a Horizon 2020 project, co-funded by the European Union (grant agreement No. 101000632), it will last 48 months and started on October 1st, 2020.

References:

[1]F. Hermanutz, M. P. Vocht, M. R. Buchmeiser, in Commercial Applications of Ionic Liquids (Ed.: M. B. Shiflett), Springer International Publishing, Cham, 2020, pp. 227-259.; [2] M. P. Vocht, R. Beyer, P. Tomasic, A. Müller, A. Ota, F. Hermanutz, M. R. Buchmeiser, Cellulose 2021, 28, 3055–3067.; [3] A. T. Smit,* A. van Zomeren, K. Dussan, L. A. Riddell, W. J. J. Huijgen, J. W. Dijkstra, and P. C. A. Bruijnincx. ACS Sustainable Chem. Eng. 2022, 10, 6012−6022.

Stephanie Pfeifer[1], Charlyn L. Greiler[1], Sarah Kröner[1], Leonie Reinders[1,2], Bernd Clauß[1], Michael R. Buchmeiser [1,2]

[1]Institute of Textile Chemistry and Chemical Fibers, Körschtalstraße 26, 73770 Denkendorf (Germany)

[2]Institute of Polymer Chemistry, University Stuttgart, Pfaffenwaldring 55, 70550 Stuttgart (Germany)

P9: Novel Zirconia Toughened Alumina Fibers

Ceramic matrix composites (CMCs) are highly demanding materials combining the advantages of monolithic ceramics, i.e. high strength, temperature stability and corrosion resistance, with high damage tolerance and fracture toughness. New oxide ceramic fibers are becoming increasingly important as an essential component of oxide ceramic composites (OCMCs) for technical applications in aerospace and power engineering industries. While commercial fibers are only available in two material compositions (corundum and corundum/mullite), the research and development of new fibers with alternative compositions is of great importance as the high temperature resistances of the fibers need to be further improved.

Zirconia (ZrO2) is known to limit grain growth in bulk ceramics and to enhance strength and fracture toughness, e.g. by transformation toughening. Therefore, zirconia toughened alumina (ZTA) is a very promising material for the optimization of the property profile of oxide ceramic fibers. Earlier studies at DITF already have shown the potential of alumina fibers containing up to 15 wt.-% zirconia (ZTA15). The fibers had been prepared in a discontinuous process from laboratory scale and their structure-property relationships were studied comprehensively, resulting in a promising microstructure of corundum incorporated with very fine-grained tetragonal zirconia. The objective of this project was to develop a continuous manufacturing process of ZTA ceramic fibers on a technical scale associated with the optimization of the fiber properties. The specific adaptation of the process parameters resulted in a compact and very fine-grained microstructure and a very high tensile strength of 2092 MPa for ZTA15 ceramic fibers.

Boris Bauer, Sybille Schmied
German Institutes of Textile and Fiber Research (DITF), 73770 Denkendorf (Germany)

P10: Simulation of humans' heat generation and emission

Cold stress is a problem of great social importance. High oil and gas prices cause heating costs to explode but at temperatures below 20 °C resting and light working people begin to freeze. Heat stress is equally sirious because climate change is leading to high summer temperatures worldwide. Work absences, accidents and high mortality rates are the result. Elderly and sick people are particularly affected. To investigate the various aspects of cold and heat stress in more detail, a calorimeter was developed as part of various research projects. The calorimeter electrically generates the same amounts of heat that humans generate through metabolism during various physical activities. Central element is a square aluminum plate with 20 cm edge length. Installed on the underside are heating mats. The total heating power of 30 W corresponds to 1500 W in humans and thus to an amount of heat generated by elite athletes in competitive sports. Covered by a TPU epidermis the calorimeter plate emits the same amount of heat as the human skin and that means, the calorimeter plate has at the same heat generation the same temperature as the human skin. The great advantage is that the heat generation of the calorimeter plate is completely controllable and thus heat emissions can be analyzed precisely. Depending on the choice of boundary conditions, the calorimeter plate emits heat in the form of MIR radiation, convection or evaporation. The absorption of solar heat can also be studied with the calorimeter. First measurements will be presented.

C. J. Pani[1], M. P. Vocht1, D. Bock[1], A. Ota1, F. Hermanutz[1], U. Zuberbühler[2], M. R. Buchmeiser*[1,3]

[1]German Institutes of Textile and Fiber Research (DITF), 73770 Denkendorf (Germany)

[2]Zentrum for Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg, 70563 Stuttgart (Germany)

[3]University of Stuttgart, 70569 Stuttgart (Germany)

P11: "CORA" – Development of amine-functionalized nonwovens for direct air capture

A future limitation of global warming requires active carbon dioxide (CO2) removal up to negative emissions, which can be achieved primarily by capturing CO2 from the atmosphere. In a medium to long term perspective, carbon-based fuels and chemical feedstocks will remain indispensable. Efficient atmospheric CO2 capture can act as a renewable source of raw materials as well as a negative CO2 emission. The environmentally friendly and sustainable HighPerCell® process allows the spinning of trilobal-shape cellulose fibers with a large surface area, which provide a favorable carrier material for the subsequent functionalization with branched poly(ethyleneimine) (PEI). PEI immobilized on carrier materials is a valuable alternative to aqueous amine solutions for CO2 capture from the atmosphere since the thermal desorption of CO2 from these materials usually requires less energy. Under humid conditions, a PEI-functionalized nonwoven has a sorption capacity of about 50 mg CO2/g adsorbent; complete and reversible CO2 desorption is accomplished at 80°C. The nonwoven material can be installed in a continuously operating device, which enables a continuous supply of CO2 and water for integration into Power-to-X applications.

CORA is a joint project, funded by the Federal Ministry of Education und Research (BMBF).

References:

[1] Hermanutz, F.; Vocht, M. P.; Buchmeiser M. R., in Commercial Applications of Ionic Liquids (Ed.: M. B. Shiflett), Springer International Publishing, Cham, 2020, pp. 227-259.

[2] Vocht, M. P.; R. Beyer; Tomasic, P.; Müller, A.; Ota, A.; Hermanutz, F.; Buchmeiser, M. R. Cellulose 2021, 28, 3055–3067, 10.1007/s10570-021-03697-x.

[3] Vocht, M. P.; Tomasic, P.; Beyer, R.; Müller, A.; Zuberbühler, U.; Hermanutz, F.; Buchmeiser, M. R., Macromol. Mater. Eng. 2022, 10.1002/mame.202200093

Leon Pauly*[1], Lukas Maier*[3], Ulrich Nieken[3] and Götz T. Gresser[1,2]
[1]German Institutes of Textile and Fiber Research Denkendorf, (DITF), Denkendorf (Germany)
[2]Institute for Textile and Fiber Technologies (ITFT), University of Stuttgart, Stuttgart, (Germany)
[3]Institute of Chemical Process Engineering, University of Stuttgart, Stuttgart (Germany)
*these authors contributed equally

P12: TOWARDS DIGITAL MATERIAL DESIGN – PREDICTION OF AIR PERMEABILITY OF KNITS

Mass transport through textiles is a crucial parameter in the development of garments and many technical applications. Due to multiscale structure and complex production processes, structural design of textiles is difficult to derive from certain requirements in transport properties. The derivation of the optimal structural parameters by iterating experiments is time consuming and therefore expensive. A multiscale model to simulate the air permeability of knitted fabrics could reduce development times and could help to understand the mass transport phenomena on the scales fiber, yarn and fabric. Since detailed simulation from the fiber to the knitted loop is computationally expensive, yarn is assigned as effective media. In order to evaluate the presented model, the simulated air permeabilities are compared to experiments with physical fabrics. The predicted air permeabilities determined in the simulation agree very well with the experiments. The workflow demonstrates a good concept for digital material design of knitted fabrics.

Reinhold Schneider, Sabine Frick, Cornelia Mäußnest, Stefanie Brenner
German Institutes of Textile and Fiber Research (DITF), 73770 Denkendorf (Germany)

P13: UV-curable polymers as matrix for composites

Fiber-reinforced composites have gained considerable importance in recent years, as they can withstand high mechanical loads with low weight and, unlike metallic materials, are corrosion-resistant. The curing of the polymers usually takes place in an autoclave at temperatures of 140°C and more and a reaction time of more than 1h. This causes both high procurement costs for the autoclaves and high energy costs. The use of UV-curable matrix polymers promises to shorten process times and significantly reduce energy costs.

Glass fiber-based composites could be prepared both by irradiation using a Hg lamp and with the help of UV LEDs using specific photoinitiators and prepolymer-monomer mixtures.

According to the functionality of monomer and prepolymer and their mixing ratios, formulations were developed to adjust the matrix polymer properties from elastic and soft to hard and brittle. The curing reaction was characterized by means of the rheological determination of storage and loss modulus and monitored over time.

Radiation-induced curing is associated with a sudden increase in storage and loss modulus within less than 5 seconds. In most cases, the moduli reach a constant final value after less than 1 min of irradiation, i.e. curing under UV light is very fast and proceeds within a time window of a few seconds to a maximum of 1 min. Tensile tests have shown that the tensile moduli of UV-cured specimens are comparable or even larger than those of thermally cured composites.

Marc P. Vocht[1], Antje Ota[1], Erik Frank[1], Frank Hermanutz[1], Michael R. Buchmeiser*[1,2]

[1]German Institutes for Textile and Fiber Research (DITF), 73770 Denkendorf (Germany)

[2]University of Stuttgart, 70569 Stuttgart (Germany)

P14: HighPerCell$_{Carbon}$®: Carbon fibers from cellulose

The HighPerCell$_{Carbon}$® technology is a sustainable and alternative process for the production of carbon fibers made from wood, thereby replacing petroleum-based feedstocks. By this approach, carbon fibers can be produced from biopolymers, in particular in the case of cellulose in a sustainable and particularly environmentally friendly process. The technology starts with the environmentally friendly, closed loop filament wet spinning process (HighPerCell® technology) for cellulosic fibers using an ionic liquid as direct solvent.1 Furthermore, a complete recycling of solvent and precursor fibers is possible making the process so unique and environmentally friendly. Because of their compact structure, cellulosic fibers prepared by this technology are ideal precursors for carbon fibers (CFs) as they display a virtually defect-free structure. The cellulosic filaments are converted into CFs by a low-pressure stabilization and a suitable carbonization process.2 No toxic byproducts or emissions are formed during the whole process. An environmentally friendly production of carbon fibers is elementary for a sustainable management of the important lightweight construction sector.

This work (IGF number: 21353 N) was supported by the AiF within the scope of the support program of the Industrielle Gemeinschaftsforschung und -entwicklung (IGF) of the Federal Ministry of Economic Affairs and Energy.

References:

[1] Vocht, M. P.; Beyer, R.; Thomasic, P.; Müller, A.; Ota, A.; Hermanutz, F.; Buchmeiser, M. R., Cellulose 2021, 28, 3055-3067, 10.1007/s10570-021-03697-x.

[2] Vocht, M. P.; Ota, A.; Frank, E.; Hermanutz, F.; Buchmeiser, M. R., Ind. Eng. Chem. Res. 2022, 61, 5191-5201, 10.1021/acs.iecr.2c00265.

Werner Wunderlich, Bastian Baesch, Tom Hager, Nora Müllner, Thomas Stegmaier, Chrostoph Riethmüller
German Institutes for Textile and Fiber Research (DITF), (Germany)

P15: Position-dissolving sensor yarn with length information

So far, smart textiles have mainly been visible to private consumers in the areas of health and fitness, for example in sportswear to monitor pulse rates. In order to achieve a higher market penetration of smart textiles, the product functionalities must be increased and the manufacturing processes must be implemented more cost-effectively. In the IGF-research project Nr. 21354N/1 with the short title „ Position-dissolving sensor yarn", coated yarns with different capacitive-sensory areas within a yarn are being researched. Currently, sensor yarns can already be functionalized well for various purposes with the help of winding technology. This is done, for example, by helically wrapping a conventional yarn with one or more superfine wires. The aim of the research project is to create zones of different capacitive sensitivity within a single yarn. It is no longer only possible to measure whether the yarn was touched, but also where. For this purpose, winding parameters are sequentially varied in a targeted manner and sequential coatings are carried out. For this purpose, requirements are determined and known coating processes are combined and modified in such a way that the desired properties of the yarns can be set differently in different zones. The functionality of sensor yarns can thus be significantly increased without additional contacting effort, which facilitates the implementation of smart textiles and supports the marketing of corresponding products.

Angela Funk[1], Simon König[1], Frank Gähr[1], Olvier Klimmt[2]
[1]Deutsche Institute für Textil- und Faserforschung, Denkendorf (Germany)
[2]FILK Freiberg Institute gGmbH, Freiberg (Germany)

P16: A Novel Approach to Articificial Leather Consiting only of Polybutylene succinate

Artificial leathers are usually composites consisting of a fabric layer and a coating layer. The fabric provides strength, while the coating provides a leather like feel. Unfortunately, fabric and coating are usually different materials, making recycling virtually impossible. A solution could be to make artificial leathers from only one material. Then, such a product could be fed into a recycling process as a whole without any sorting or separation effort. Here, we want to showcase such an artificial leather, consisting only of Polybutylene succinate (PBS).

Materials used for artificial leather fabrics must be spinnable, and provide sufficient strength, while the coating material has to be highly flexible, abrasion resistant, resistant to environmental influences, while overall providing a “leather-like” hand feel. The biobased and biodegradable polymer PBS has such a property profile, the aim of this project was consequently to prove the feasability of such an artificial leather and suggest necessary production process parameters

Using a commercially available PBS, multifilament partially oriented yarn (POY) melt spinning trials have been performend with winding speeds up to 3000 m/min. The spinning parameters were varied and optimized to achieve a stable spinning process and various yarn finenesses. From these POYs, flat drawn as well as textured yarns have been produced, with tenacities up to 26 cN/tex. From these yarns, three types of fabrics have been made: Knits, wovens, and staple-nonwovens. Afterwards, the fabrics have been successfully coated to form the first prototypes of PBS-artificial leather.

Simon Ringger, Hagen Altmann
Deutsche Institute für Textil- und Faserforschung (DITF), Denkendorf (Germany)

P17: Nonwoven Reinforced Membranes for Electrolysis, Batteries and Fuel Cells

Solar energy and other types of renewable energies are synonymous with the energy revolution in Germany. One key technology for storing the energy generated is alkaline water electrolysis. The development of a demonstrator in megawatt size is the goal of the joint research project ‚Electrolysis made in Baden-Württemberg' led by the Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW). The DITF's task here is to develop and produce membranes for the electrolysis cell.
Such membranes are already commercially available, but they usually have high ohmic resistance due to their material thickness. Thinner and more efficient membranes with better electrochemical properties have so far not been robust enough and are vulnerable to mechanical stress. They are prone to stress cracking and material failure, especially when used in larger cells.
DITF therefore reinforces ultra-thin membranes by using supporting nonwovens made of ultra-fine fibres (fibre diameter 0.2 – 2 µm). The development of suitable ultrafine fibre nonwovens with customised properties is just as big a challenge as the production of the membranes themselves. The first promising membranes are available and are being tested and optimised with regard to their suitability for practical use. Additionally, a frame construction made of composite materials is also intended to absorb mechanical pressure loads during assembly in the demonstrator.

Olga Zilke[1], Dennis, Plohl[1], Klaus Opwis[1], Jochen S. Gutmann[1,2]
[1]Deutsches Textilforschungszentrum Nord-West gGmbH (DTNW), Krefeld
[2]Institut für Physikalische Chemie und CENIDE (Center for Nanointegration), Universität Duisburg-Essen, Essen

P18: Nature-based flame-retardant textile coatings

Bio-based flame retardants represent an alternative to synthetic, halogenated compounds. For instance, down contain about 16% nitrogen which makes them suitable for the incorporation in combustible materials. In this study, rejected down from goose down processing were hydrolyzed to obtain keratin hydrolysate for flame-retardant textile coatings. Another approach deals with phytic acid as a natural source of phosphorus. Phytic acid was combined with nitrogen-containing compounds to prepare flame-retardant textile coating.

Using a binding agent, cotton, polyester, and polyester/cotton blended fabrics were coated with keratin hydrolysates and the precipitated phytic acid salt, respectively. No after flame time was observed in flame tests according to ISO 15025. Further experiments regarding the pyrolytic as well as the combustion behavior were conducted by means of TGA and MCC.

Acknowledgement:

The project (ZF4139706 AJ9) is supported by the Federal Ministry for Economic Affairs and Climate Action (BMWK) on the basis of a decision by the German Bundestag. The research project BIO PHY FR is supported by the Federal Ministry for Economic Affairs and Climate Action and the AIF (German Federation of Industrial Research Associations eV) within the framework of the industrial collective research (IGF) program (IGF No. 22349 N), based on the decision taken by the German Bundestag.

Dominic Danielsiek[1], Wael Ali[1,2], Yannik Leven[1], Laura Chromik[1], Jörg Müssig[3], Nina Graupner[3], Jochen S. Gutmann[1,2] and Thomas Mayer-Gall[1,2]
[1]Deutsches Textilforschungszentrum Nord-West (DTNW), Krefeld (Germany)
[2]Department of physical Chemistry and Center for Nanointegration Duisburg-Essen (CENIDE), University Duisburg-Essen, Essen (Germany)
[3]Biomimetics-Innovation-Centre (B-I-C) / The Biological Materials Group, Bremen University of Applied Sciences, Bremen (Germany)

P19: Flame retarding and smoke suppressant textiles for natural fibre reinforced composites

Esteemed for their tensile strength, processability, and their widespread natural abundance, cellulose-based fibres, such as flax and rayon find application not only for apparel and home textiles, but also in construction and transportation. With a global strive towards energy-efficiency and a responsible utilization of resources, lightweight construction plays a key role in modern automotive, aviation, and naval design. Natural fibre reinforced composites offer a promising approach, as they provide a green alternative to artificial fibre reinforcements, such as aramid and glass fibres.[1] However, the combination of inherently flammable natural fibres and a strongly smoke producing polymer matrix drastically limits their usability. These challenges need to be adressed with smoke suppressant flame retarding additives. Since classical flame retardants for polymer materials, based on halogen compounds, are classified as toxic and environmentally concerning, halogen-free replacements need to be developed.[2] As green alternatives, several organophosphorus and organonitrogen compounds are reported but lack a smoke suppressing capability. Boric acid and its salts, in contrast, are effective smoke suppressants, but are classified as substances of very high concern (SVHC) under REACH.[3] In order to develop a safer solution to provide borons smoke suppressing effect, halogen-free organoboron compounds (not concerned by SVHC rating) containing phosphorous and nitrogen are investigated as flame retardants for flax and rayon as composite reinforcements. The chemical integration of boron in the organic compound, combined with immobilization of the flame retardant on the textile as well as the embedding of the textile in the polymer matrix are expected to prohibit environmental exposure while providing smoke suppressant and flame retardant properties to the composite.

[1]Gholampour, A., Ozbakkaloglu, T. A review of natural fiber composites: properties, modification and processing techniques, characterization, applications. J Mater Sci 2020, 55, 829–892
[2]de Wit, C. A. An Overview of Brominated Flame Retardants in the Environment. Chemosphere 2002, 46 (5), 583–624
[3]ECHA (2021, July 30), Boric acid. https://echa.europa.eu/de/substance-information/-/substanceinfo/100.030.114

Jessica Schneider[1], Dorothee Schmiemann[2], Suzan Yalman[3], Klaus Opwis[1], Kerstin Hoffmann-Jacobsen[2], Holger Zorn[3], Jochen S. Gutmann[1,4]
[1]Deutsches Textilforschungszentrum Nord-West gGmbH (DTNW), Krefeld
[2]Hochschule Niederrhein, Fachbereich Chemie und Institut für Lacke und Oberflächenchemie, Krefeld
[3]Justus-Liebig-Universtität Gießen, Institut für Lebensmittelchemie und Lebensmittelbiotechnologie, Heinrich-Buff-Ring 17, 35392 Gießen
[4]Institut für Physikalische Chemie und CENIDE (Center for Nanointegration), Universität Duisburg-Essen, Essen

P20: Immobilization of enzymes on textiles and their benefits for modern biotechnology

The combination of enzymes as highly reactive biocatalysts and textiles as a cost-effective and flexible support material offers many benefits for application in modern biotechnology. Enzymes offer the advantage that they can be used at moderate temperatures, at pH ranges close to neutral, and they are safe and easy to handle. Furthermore, enzymes have a high substrate selectivity and small quantities are enough for a sufficiently high implementation rate. Another advantage is their reusability because they stay unchanged after the reaction. Therefore, the idea is to immobilize the biocatalysts on suitable carrier materials, to reuse them easily and improve the economical use of the high-priced enzymes. Some synthetic or natural textile fiber materials such as polyester, polyamide or cotton are adequate carrier materials. They are comparatively inexpensive, their flexibility allows the use in reactors of any geometry, and they can be separated fast and without contamination of the reaction batch. Here, we present various methods for the immobilization of oxidoreductases (peroxidases and laccases) on textile carrier materials and their potential application, e.g., in the gentle enzymatic degradation of food colors, the synthesis of natural flavors, or the degradation of micropollutants in sewage water.

Larisa Tsarkova[1], Christina Schippers[1], Daniela Weißland[1], Patrick Engel[2], Jochen S. Gutmann[1,3]
[1]Deutsche Textilforschungszentrum Nord-West (DTNW), Krefeld (Germany)
[2]Sächsisches Textilforschungsinstitut e.V. (STFI, Chemnitz (Germany)
[3]Department of Physical Chemistry, University Duisburg-Essen and CENIDE, Essen, Germany

P21: Structural and chemical design of nonwovens for oil/water separation

Nonwoven media for liquid filtration, including oil-water separation and oil split cleaning, represent an important product segment in the field of technical textiles.

While oleophobic behavior in contact with air is not feasible to achieve without an application of fluoroalkane-based chemistry, the superoleophoby under water is achievable by creating superhydrophilic surfaces which provide selective wetting by water phase and thus prevent oil-fauling.

This approach was studied by designing PES nonwoven filter media with superhydrophilic coatings based on polyelectrolytes, hydrogels as well as zwitterionic polymers. The most effective behavior in terms of separation of finely dispersed oil droplets was demonstrated by the coating of polyvinylamin modified with sulfobetain groups (PVamSB).

Besides chemical modification of the fibers, a textile-constructive approach towards selective wetting of the media have been implemented. Mixed nonwovens from hydrophobic (PES, PP) and hydrophilic (regenerate cellulose) fibers with controlled both composition and textile-technical parameters have been tested for oil-water separation. The higher is the fraction of the hydrophobic fibers in the mixture, the more oil is separated, while the wetted viscose fibers provide capillary ways for water transport.

Presented results suggest design strategies for efficient filter media.

Mujo Adanalic[1], Larisa Tsarkova[1], Jochen S. Gutmann [1,2]
[1]Deutsche Textilforschungszentrum Nord-West (DTNW), Krefeld (Germany)
[2]Department of Physical Chemistry, University Duisburg-Essen and CENIDE, Essen, Germany

P22: Functionalization of textile surfaces by light-induced grafting of benzophenone derivatives

Common method for surface functionalization of textiles is a thermal treatment step to fix the finishing formulation, which are applied by dipping, padding or doctorblading techniques. More energetically favorable are photochemical methods, which also allow patterned functionalization of the fabric surface by using masks or by localized deposition of the finish.

The aim of this research project is to develop a universally usable photochemical approach in which, in contrast to known UV methods, the effects are not achieved via crosslinking (curing) of monomers but rather by direct covalent attachment to the surface.

For this purpose, bifunctional finishing chemicals, consisting of a UV-reactive surface anchor benzophenone group and a functional unit, e.g. alkyl chains, are developed. The activation of the treated textiles with UV bright band source oder with LED leads to the formation of very thin hydrophobic layers with good permanence. The attachemnet mechanism is based on the C-H insertion reaction and therefore is unversial for polyester, polyolefine and cellulose substrates.

The possibility to vary the performance of thin hydrophobic layers by application of mixed layers with varied alkyl chain length is discussed.

The initial focus is on the development of water- and soil-repellent finishes. However the approach allowes other functionalisation variants, such as hydrophilization of inert polyolefine surfaces by applying sulfobetain benzophenone derivatives. Furthermore, patterned functionalisation of textile surfaces, which is particularly interesting for the field of technical textiles, is demonstrated.

Alaa Salma[1], Verena Stenert[2], Martin Cornelsen[2], Andrea Börgers[3], Jochen Türk[3,4], Jochen S. Gutmann[1,5], Thomas Mayer-Gall[1,5]
[1]Deutsche Textilforschungszentrum Nord-West (DTNW), Krefeld (Germany)
[2]Cornelsen Umwelttechnologie GmbH, Essen (Germany)
[3]Institut für Energie- und Umwelttechnik e. V., (IUTA, Institute of Energy and Environmental Technology), Duisburg (Germany).
[4]Centre for Water and Environmental Research (ZWU), University of Duisburg-Essen, Essen (Germany)
[5]Department of Chemistry and Center for Nanointegration Duisburg-Essen (CENIDE), University Duisburg-Essen, Essen (Germany)

P23: Development of textile adsorbers for adsorption of micropollutants from the wastewater treatment plant effluent

Micropollutants have been founded in the water sources which indicates their ineffective removal by conventional water treatment technologies. Many studies have confirmed the presence of pharmaceuticals and polyfluoroalkyl substances in the range of ng L-1 to µg L-1, in surface water, groundwater and even drinking water. Therefore, under the water framework directive (WFD) of the European commission, environmental quality standards (EQS) have been established for 33 substances, the so-called priority substances and eight other pollutants were listed in the Annex X of the WFD to be monitored. The EQS proposed a maximum level of 0.1 µg L-1 for diclofenac, 0.5 µg L-1 for carbamazepine and 0.15 µg L-1 for sulfamethoxazole in surface waters. The Stockholm Convention listed perfluoro-octane sulfonic acid as a persistent organic pollutant and has recommended to include the perfluorooctanoic acid. However, these micropollutants are survive most of the conventional techniques in drinking- and wastewater treatment and were observed in finished drinking water in Germany, USA and other countries. Thus, drinking water suppliers have to deal with the possibility of elevated micropollutants concentrations in their raw water and thereby need to consider treatment strategies as barriers for micropollutants.

In this work, micropollutants absorbing filters were developed based on textile fibers coated with polyelectrolytes. The surface modification of the textile material is possible with common textile finishing methods (padding), performing cheap adsorbents for micropollutants removal.

Susanne Braun[1,2], Markus Ottersbach[1,2], Thomas Ebbinghaus[1,2], Sven Buschmann[1,2], Robert Kaufmann[1,2], Andrij Pich[1,2,3]
[1]DWI – Leibniz Institute for Interactive Materials, Aachen, Germany.
[2]Institute for Technical and Macromolecular Chemistry (ITMC), Research Area Functional and Interactive Polymers, RWTH Aachen University, Aachen, Germany.
[3]Aachen-Maastricht Institute for Biobased Materials (AMIBM), Maastricht University, RD Geleen, Netherlands.

P24: Antibacterial zinc peroxide-based coatings for air filtration systems

The past years of the pandemic have clearly shown how important clean and germ-free air is for human health. Although many air filters have a high efficiency even for very small particles, many of these filter systems are susceptible to microbial contamination, for example with bacteria or fungi.

The aim of this research project is to equip commercial air filters with zinc peroxide-based particles so that a long-lasting growth inhibition of bacteria and pathogens is ensured.

Therefore, zinc peroxide (ZnOO) particles are used as antibacterial agents to modify commercial air filters. Both the size and the functional groups on the surface of the ZnOO particles can be controlled by varying the stabilizers used during the synthesis. To bind the stabilized particles to the fiber surface of commercial polyester-based air filters, the fibres are modified with amine groups. Subsequently, the ZnOO particles can be applied to the fibers using dip-coating techniques which are resulting in an attachment either by electrostatic interactions or by covalent bonding. Antimicrobial tests show the efficacy of the equipped air filter systems. Thermal ageing was used to investigate the long-term activity of the system for lifetimes of one, two and three years. Further the equipped fiter materials have been tested in terms of their filtration efficiency compared to the unmodified filter material.

Niklas Herrmann[1], Melina Schadt[1], Wolfgang Frohn[2], Elisabeth Heine[1], Felix Jakob[1], Andreas Herrmann[1,3], Ulrich Schwaneberg[1,4]
[1]DWI – Leibniz Institute for Interactive Materials, Aachen, Germany
[2]FROHN GmbH, Schauenstein, Germany
[3]Institute of Technical and Macromolecular Chemistry, RWTH Aachen University, Germany
[4]Institute of Biotechnology, RWTH Aachen University, Germany

P25: Bio-based coatings for sustainable high-tech textiles

Textile finishing describes different chemical and mechanical processes for the modification of a textile's properties, thereby making it more appealing for the consumer. Common finishes require the use of chemicals to achieve desired effects like moisture management, smoothness or antibacterial efficacy. Many of these chemicals are known to pose as health hazards for the manufacturer as well as the consumer and contribute to environmental pollution. Therefore, the textile industry is in search of sustainable and economically friendly bio-coatings that at the same time allow finishing of bio-based fibers to strive towards a circular economy.

This work involves the development of a platform technology for peptide-based adhesion promoters (anchor peptides) that can be combined with different functional moieties for designing tailor-made and long-lasting textile finishes. Anchor peptides are short natural peptides with an amphiphilic character that have already been shown to be applicable for the coating of a variety of natural and synthetic surfaces by eco-friendly dipping or spraying techniques. The adhesion promoters will on the one hand be combined with antimicrobial moieties to prevent the spread of pathogenic microorganisms including multi-resistant bacteria. On the other hand, bio-based hydrophilic coatings will be developed that improve the wetting behavior and moisture management on e.g. sports textiles while not influencing the textile's biodegradability in a negative manner.

Within our research project, we will evaluate the protein-based coatings in comparison to current standards of high-tech textiles in the fields of sports-, medical- and home textiles.

Elisabeth Heine[1], Rudolf Lütticken[1], Ghazi Khalfallah, Rita Gartzen[1], Andreas Herrmann[1,2]
[1]DWI – Leibniz Institute for Interactive Materials, Aachen, Germany
[2]Institute of Technical and Macromolecular Chemistry, RWTH Aachen University, Germany

P26: ProbioPatches 2.0 – Antimicrobial patches with selectively switchable probiotic bacteria for the therapy of skin infections without antibiotics (LIVING THERAPEUTICS)

The increasing development of antibiotic resistance of microbial pathogens and the associated severe, often fatal, courses of disease are the driving force behind research into alternative and adjunctive treatment methods. This also includes the development of innovative acne therapies and wound care systems.
Based on the patented ProbioPad (IGF 18970N), the DWI further develops functional ProbioPatches1 with enclosed probiotic bacteria that release antimicrobial agents in a targeted manner for the treatment of infected skin and wounds. Specifically, switchable and bacteriocin-hyperproducing probiotic bacteria are developed and used. To this end, molecular biology techniques are used to optimize the probiotic bacteria for their use in wound patches so that their production of antimicrobially active ingredients (bacteriocins) is significantly increased. In addition, the ProbioPatches are configured in such a way that intensive active ingredient production only starts when pathogenic bacteria appear on the skin / in the wound, thus indicating infection.
The bacteria are enclosed between an outer impermeable membrane and a semi-permeable membrane on the skin side and do not get onto the skin or into wounds. The ProbioPatches 2.0 are being optimized with regard to their subsequent applicability on skin and wounds.
The performance of the patches is tested and evaluated against relevant pathogenic bacteria (e.g. C. acnes, S. aureus and P. aeruginosa).
A high economic benefit is expected, as secondary diseases are reduced, hospital stays are shortened, and thus savings are to be expected in the healthcare system.

DWI project IGF 22331 N

Elisabeth Heine[1], Rita Gartzen[1], Andreas Herrmann[1,2], Rudolf Lütticken[1]
Isabel Hofmann[3], Sabrina Kolbe[3], Robert Groten[3]
[1]DWI – Leibniz Institute for Interactive Materials, Aachen, Germany
[2]Institute of Technical and Macromolecular Chemistry, RWTH Aachen University, Germany
[3]Hochschule Niederrhein, Textil- und Bekleidungstechnik, University of Applied Sciences, Germany

P27: ProSwabs – Efficient swab system for precise laboratory diagnostics and consecutively specific antibiosis and disinfection

Precise diagnostics of pathogens e.g. in hospitals makes a specific medication possible, prevents the spread of multi-resistant bacteria, and is an important cost saving factor.

Specific antibiosis and disinfection can only be achieved if the pathogens are collected during sampling and are maintained viable or detectable during transport, in order to ensure their precise identification in the analytical laboratory. During sampling, swabbing is used to avoid inconveniences for the patients, time delays, and costs and risks.

However, the efficiency of currently available swabs is dependent on factors like swab material, bacterial strains and handling of the swabs.

To this end, within this work, an innovative swab system is developed. The whole sampling system is being designed in such a way that both, uptake and release of pathogens are carried out in an optimal way and regardless of the way of use.

Swabs are deployed in many areas of healthcare: for DNA tests, antigen tests, assessment of wound infections, medical screening, hygiene swabbing of surfaces etc. Thus, with more efficient swabs, an increasing market will be further developed also considering the demographic development.

Inga Litzen[1,2], Steven Zimmer[1,2], Jacek Walkowiak[1,3], Rostislav Vinokur[1], Marta Santi[1], Thomke Belthle[1,2], Dan Demco[1,2], Andrij Pich[1,2,3]
[1]DWI – Leibniz Institute for Interactive Materials, Aachen, Germany
[2]Institute of Technical and Macromolecular Chemistry, RWTH Aachen University, Germany
[3]Aachen Maastricht Institute for Biobased Materials, Maastricht University, Geleen, The Netherlands

P28: Hydrophilic Microgels as Anti-Ice Surface Coatings

Ice formation poses a problem to a variety of applications of outdoor textiles, such as tarps and covers for trucks or tents, as well as clothing like jackets, shoes and backpacks. However, anti-ice properties significantly improve their efficiency and lifetime. Current strategies are mainly based on functionalisation with polyfluorocarbons, which makes the surfaces superhydrophobic. Since these substances are environmentally harmful, alternative textile modifications are of interest for current research.

Hydrophilic microgels have shown to be promising candidates for application as new environmentally friendly anti-ice coatings. They establish a hydration layer at the surface which enables the facile removal of ice compared to untreated textiles during strain-force-measurements.

Since ice formation and removal involves many complex processes, it is crucial to have a reliable measurement set-up. For this work, a custom set-up was developed based on a material testing machine to determine the ice adhesion strength for tensile stress. Reproducable results could be obtained for different types of model substrates including textiles. The suitability of microgels based on the biocompatible monomer N vinylcaprolactam and hydrophilic co-monomers as anti-ice coatings was tested. The influence of the co-monomer and crosslinker content was explored. Coating quality and durability were analysed with X-ray photoelectron spectroscopy and Scanning Electron Microscopy. The interactions of the synthesised microgels with water during freezing was studied in detail by determining the amount of surface bound water with Differential Scanning calorimetry and Nuclear Magnetic Resonance Spectroscopy. Microgels without the hydrophilic co-monomer as well as linear polymers were investigated as reference systems.

Laura Hetjens[1,2], Andrij Pich[1,2,3]
[1]Institute of Technical and Macromolecular Chemistry, RWTH Aachen University, Aachen, Germany
[2]Functional and Interactive Polymers, DWI – Leibniz Institute for Interactive Materials e.V., Aachen, Germany
[3]Aachen Maastricht Institute for Biobased Materials, Maastricht University, Geleen, The Netherlands

P29: Biobased flame retardant finish for cardboard and textiles based on polyphenol poly-phosphazenes

The design of new biobased and environmentally-friendly flame retardants (FR) is of great importance, especially in the construction, electrical and textile industries. Due to updates of safety and environmental regulations, syntheses of FR materials continuously meet new challenges. Therefore, the current interest is the development of new, halogen-free FR to reduce the environmental and health impact.[1]

The present work is concerned with the development of sustainable halogen-free cyclomatrix polyphosphazene coatings for textiles or cardboard. This will be realized by combining the phosphornitrilic chlorid trimer (HCCP) with biobased polyphenols. The synthesis is started by base addition and the cyclomatrix colloids are formed by a precipitation polycondensation. Mild reaction conditions, simple purification and scalability are favorable to improve the sustainability even further.[2] This new FR material promises high thermal stability, low degradation, and high charring conditions due to a high phosphorus and nitrogen content.

After deposition of the FR coating on the surface of textile fibers or cardboards the flame retardant activity was evaluated. The flame-retardant activity of polyphenol-polyphosphazenes can be directly influenced by the polymer composition and the coating amount. The influence of the chemical composition of the biobased polyphenol-polyphosphazenes colloids on the thermal stability and performance as FR was systematically investigated in bulk and as coatings or cardboards on textiles by various analytical methods like thermogravimetric analysis, vertical flame tests and Limiting Oxidation Index (LOI) measurements.

References

[1] M. M. Velencoso, et al., Angewandte Chemie, 2018, 130, 10608.
[2] Deniz, Ayse, et al., ACS Applied Polymer Materials 2.12, 2020, 5345-5351.

This work is part of the AiF-Project “BioFlamm”.

Barbara Dittrich[1], Tina-Marie Thomas[1], Marc Becker[3], Maria Restrepo[2], Stephan Emonds[2], Ang Zhao[2], Quing Cui[2], Hannah Roth[2], Matthias Wessling[1,2], Andreas Herrmann[1,3]
[1]DWI – Leibniz Institute for Interactive Materials, Aachen, Germany
[2]AVT.CVT RWTH Aachen University, Aachen, Germany
[3]Institute for Technical and Macromolecular Chemistry, RWTH Aachen University, Aachen, Germany

P30: Supercharged unfolded polypeptides for the functionalisation of polyelectrolyte fibres

In the case of implants, the interaction of the product surface and morphology with its environment determines the extent to which an inflammatory reaction and rejection by the surrounding body tissue occurs. Hernia treatment is one of the most important fields of application for textile implants. The aim of the project is to establish a novel technology for the production of fibres with antimicrobial properties, in which antimicrobial substances can be incorporated directly into the polymer matrix of the fibre. For this purpose, biocompatible polyelectrolyte fibres with integrated supercharged unfolded polypeptides (SUPs) are to be produced in a wet-spinning process.

This recombinant highly charged peptides are derived from the primary structure of tropoelastin a precursor of elastin. Elastin is the main component of the highly elastic fibres of the extracellular matrix (ECM). The genetic engineering synthesis approach opens up access to recombinant peptides that carry high charge densities. Here, the repetitive hydrophobic consensus sequence of elastin (VPGXG)n is used as a building block, where X stands for lysine (for embedding a positive charge) or for glutamic acid (for embedding a negative charge). To provide the SUPs with antimicrobial properties, sequences with known antimicrobial properties are integrated into the peptide sequence. Fluorescent fusion proteins are used for compatibility tests and in fibre spinning trials. For fibre production on an industrially relevant scale, optimisation and scale-up of the production of the recombinant fusion proteins is required. For this purpose, the cultivation and purification protocols are optimised and scaled up.

Barbara Dittrich[1], Tina-Marie Thomas[1], Hana Lukesova[2], Hartmut Kutzke[2] Andreas Herrmann[1,3]
[1]DWI – Leibniz Institute for Interactive Materials, Aachen, Germany
[2]Museum of Cultural History, University of Oslo, Oslo, Norway
[3]Institute for Technical and Macromolecular Chemistry, RWTH Aachen University, Aachen, Germany

P31: Bioinspired glues for the conservation of archaeological textile artefacts

The project TexRec - Virtual Reconstruction, Interpretation and Preservation of the Textile aArtifacts from the Oseberg Find - is the first comprehensive analytical study on the figural and geometric weaves called tapestriesrescued from the Oseberg gravemound. The project focuses on the scientific examination of the find, covering the degradation pathways of archaeological textile fibres, the examination of weaving techniques of the fragment group and dyeing procedures used in the Viking Age. Moreover, a virtual reconstruction of the objects will be generated. The project aims to understand better the Vikings' beliefs and myths by interpreting the motifs depicted on the tapestries and plans the dissemination of the results and presentation of the virtual reconstruction to the public.

In the framework of the project, conservation strategies will be developed and evaluated, focusing on bio-inspired materials, to preserve the unique artifacts. DWI developed a family of protein glues based on supercharged unfolded polypeptides (SUP) for the use in medical applications, e.g. glues to support wound healing. These glues will be optimized and their application for preservation of archaeological textile will be evaluated.

Claudia Lüling[1], Sascha Biehl[1], Roxana Tennert[1], Gözdem Dittel[2], Marina Chernyshova[2]

[1]FRA-UAS, Frankfurt University of Applied Sciences, Frankfurt, Germany

[2]ITA, Institut für Textiltechnik of RWTH Aachen University, Aachen, Germany

P32: 6dTEX - Lightweight building components made of 3D-textiles in combination with 3D-printing

6dTEX deals with the synergetic combination of two technologies that have so far been utilized separately: 3D printing processes and 3D textile production for sustainable applications in the building industry. In addition, the choice of the same material groups for both, the printing and the textile material, will also enable the production of single-origin, recyclable components.

The aim is to generate a new type of lightweight construction for the building envelope by optimizing technical 3D textiles in combination with additive 3D printing processes. The printing material is minimized in terms of load bearing requirements and is correspondingly optimized. It is combined with a 3D textile that is also precisely optimized for load transfer in the X, Y and Z axes of the textile geometry. Depending on the requirements and applications, the 3D textile can further be programmed (opaque/ translucent/ insulating). The interplay of hard printing material and soft textile also promises aesthetically convincing solutions.

The project is designed on an experimental basis. In an iterative process, potentially combinable printing and fiber materials have been catalogued and evaluated. In the next step, orienting experiments with 3D printing on 2D textiles (warp-knitted biaxial fabrics) were undertaken to test the adhesive bond. Based on this, right now textiles are designed with geometries and surface structures that enable the adhesive bond and other functions. This is followed by printing trials on and into the 3D textile with linear and point structures. So far, four application options have already been defined for the final building demonstrators, two of which are to be realized.

Markus Oberthür[1], Sabine Gärtner[2], Carsten Westarp[3]
[1]HAW (Hochschule für Angewandte Wissenschaften) Hamburg, Department of Design, Division of Textile Engineering, Hamburg, Germany
[2]HAW (Hochschule für Angewandte Wissenschaften) Hamburg, Department of Design, Division of Textile Design, Hamburg, Germany
[3]HAW (Hochschule für Angewandte Wissenschaften) Hamburg, Department of Industrial Engineering, Physics Laboratoy, Hamburg, Germany

P33: Acoustic insulation using woven fabrics

Various studies show that a constant exposure to sounds and noise promotes the development of various medical conditions, e.g. cardiovascular diseases and hormonal imbalances, as well as stress-related symptoms and sleep disorders. As a result, noise exposure reduces work productivity and the general well-being and comfort of people in offices, but also in a private setting. Noise cancelling installations are often wall hangings and room partioners made from solid sound absorbing materials. Other measures are sound absorbing curtains and wall hangings made from special fabrics. In addition to the actual acoustic insulation capabilities of such sound absorbing textiles, aesthetic aspects have also to be considered, as this also affects the well-being of people working and living in these spaces. Therefore, we initiated a project towards the development of woven fabrics with sound absorbing qualities using a multidisciplinary approach that combines material and technological aspects with textile design.

As part of the project, we produced a variety of woven fabric pobes with different weave types and warp and weft densities. The sound absorbing qualities of these fabrics were then analyzed using an impedance tube. The results showed the influence of various parameters on the total sound absorption and the frequence-dependent absorption. Based on these results, larger prototypes were made using a digital jacquard loom, and subsequently analyzed in an echo chamber.

My Linh Luong[1], Teresa Kusenbach[1], Zijin Feng[1], Mariame Diallo[1], Lilia Sabantina[1,2]

[1]Niederrhein University of Applied Sciences, Department of Textile and Clothing Management, Moenchengladbach, Germany

[2]Junior Research Group "Nanomaterials", Bielefeld University of Applied Sciences, Faculty of Engineering and Mathematics, Bielefeld, Germany

P34: Fashion Technology – How Technology is Changing the Fashion Industry?

The incorporation of technology into the fashion industry is pushing the boundaries of what the fashion world has done before, combining traditional fashion elements and textiles with smart technology. Designs that were previously only possible on paper are being brought to life thanks to modern technologies like 3D printing. In addition, both fashion and technology have become increasingly accessible to consumers in recent years. As a result, brands are able to interact and engage with their communities by revolutionizing online shopping experiences and runway shows, but also by simply being active on social media platforms. This review paper examines the use of technology in the areas of haute tech couture, virtual fashion shows, virtual stores, and social media marketing. The purpose of these review papers on fashion technology is to examine how technology has impacted the fashion industry and to appreciate its role in innovation and sustainability.

Rike Brendgen, Carsten Graßmann, Theresa Junge, Laura Hegers, Thomas Weide, Anne Schwarz-Pfeiffer
Research Institute for Textile and Clothing, Niederrhein University of Applied Sciences, Mönchengladbach (Germany)

P35: Humidity sensing hybrid yarns produced on a hollow spindle spinning machine

Monitoring body parameters is of great interest in the field of smart textiles. Moisture sensors can be used to monitor body fluids such as sweat or urine. In this study, hybrid yarns were produced on a hollow spindle spinning machine to detect moisture. In this process, electrically conductive yarns and strands as core yarns were wrapped with an insulating viscose yarn. The wraps were placed tightly enough to completely cover the core the yarn. Another conductive yarn was twisted around the wrapped yarn. The produced hybrid yarn thus forms a capacitor. The viscose yarn, which serves as an insulator, absorbs moisture so that the capacitance of the capacitor changes with the relative humidity in the environment.

Following electrically conductive core yarns were studied:

- stainless steel multifilament yarn (Bekinox VN 14.2.9 from Bekaert)
- silver-plated copper on p-aramid yarn (Highflex 7077 from Karl Grimm GmbH)
- insulated copper wire with a diameter of 0.2 mm (Polysol P 155 from Elektrisola)

Following yarn was investigated as counter electrode:

- silver coated polyamide/polyester hybrid twist yarn (Silver-tech from Amann)

The change in capacitance of the hybrid yarn was studied by conditioning between 20 and 80% relative humidity at 20°C. All produced yarns showed sensitive properties and increased their capacitanceupon rising relative humidity. Differences are observed for the individual core materials and the number of twists of the viscose yarn. The produced twisted yarns can be integrated as seam yarn in clothes to monitor the humidity of the human skin.

This work was financed by the Collective Research Network (Cornet) supported by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) under the support code 277 EN.

Lisa Streitenberger, Prisca Holderied, Julia Klausmann, Thomas Mutschler, Marcus O. Weber
Niederrhein University of Applied Sciences, Forschungsinstitut für Textil und Bekleidung, Mönchengladbach, Germany

P36: Investigation of the influence of material composition on sustainable yarns made from German hemp and pure recycled wool

Currently, only a small amount of the world's textile waste is recycled; the majority is disposed of in landfills. This problem can be avoided by producing biodegradable textiles.

In the „CannaReWool" project, hemp grown in Germany is spun into yarns with pure recycled wool and then knitted. Hemp is considered to be a very sustainable, resource-saving fibre alternative. It requires little water for cultivation and grows well in the regional climate. To balance the feel of the relatively stiff fibres in the end product, it is blended with recycled wool. The resulting textiles are recyclable and have a low negative impact on the environment.

The textile process chain is covered in the trials up to the formation of the fabric. The fibres are mixed together, carded and then spun, using the rotor spinning process. The mixing ratios of hemp and wool are 75:25, 50:50 and 25:75. The aim is to produce a knitting yarn with a fineness of Nm 15; Nm 8 and Nm 12 are also spun for comparison.

For validation purposes, the yarns will be processed into fabrics on flat and circular knitting machines.

The yarns are examined with regard to their fineness, evenness, hairiness, strength and twist. Based on these results, the technical manufacturing processes are optimised. Due to the different mixing ratios, the influence of the raw material can be measured with the help of the test results.

The interim results of the project are presented on the poster.

This project was funded by the European Regional Development Fund (ERDF) (ERDF funding code: EFRE – 0802000)

Prisca Holderied[1,2], Thomas Mutschler[1], Julia Klausmann[1], Lisa Streitenberger[1], Marcus O. Weber[1], Marie-Ange Bueno[2]
[1]Niederrhein University of Applied Sciences, Forschungsinstitut für Textil und Bekleidung, Mönchengladbach, Germany
[2]University Haute-Alsace, Laboratoire de Physique et Mécanique Textiles (LPMT, UR 4365), Mulhouse France

P37: Comparison of an innovative knitting technique with technical weavings and conventional knitted structures

The increasing demand for technical textiles makes innovations in this field as well as an acceleration of processes necessary.

In the research presented on the poster, an innovative knitting technology for the production of technical textiles was developed. With the help of this technology, conventional knitting structures can be knitted more productively. Moreover, a completely new type of knitted fabric is created, a doublejersey knit, onto which a singlejersey knit is plated from both sides. On the poster we present the properties of these novel knitted structures and explain their advantages and potential ares of application.

For this, six innovative plated knitting structures in various finenesses were subjected to different tests. The tests include fabric weight, thickness, air permeability, tear resistance, maximum tensile force and burst pressure.

Subsequently those plated knitting structures were compared with two technical canvas weaves and six knitted standard structures (doublejersey) of the same material. The canvas weaves and the standard knittied structures serve as a reference.

It is found that all knitted fabrics withstand higher tear strength than woven fabrics. Additionally, all knitted fabrics are more air permeable compared to the tested woven fabrics while being thicker and heavier at the same time. In contrast to the standard knitted fabrics, the innovative plated knitted structures show less air permeability. The tests on burst pressure and maximum tensile fore are currently being carried out.

The test results are presented on the poster, as well as potential areas of application such as protective, construction or mobility textiles.

This project was funded by the European Regional Development Fund (ERDF) (ERDF funding code: EFRE – 0400310).

Boris Mahltig[1], Henning Lichtenberg[2], Alexander Prange[2], Wantana Klysubun[3], Josef Hormes[4]

[1]Hochschule Niederrhein, Faculty of Textile- and Clothing Technology, Mönchengladbach, Germany

[2]Hochschule Niederrhein, Department Research and Transfer, Krefeld, Germany

[3]Synchrotron Light Research Institute, Nakhon Ratchasima Thailand

[4]Rheinische Friedrich-Wilhelm-University, Institute of Physics, Bonn, Germany

P38: Synchrotron based X-ray spectroscopy for the analysis of inorganic fibers – especially basalt fibers

X-ray spectroscopic methods based on synchrotron radiation are helpful tools for the investigation of oxidation and crystallization processes in inorganic materials and therefore also suitable for the investigation of structural changes in inorganic fibers. They enable to correlate changes in the absorption behavior of selected chemical elements in the fibers with changes in their mechanical properties and performance uponheat exposure. Thus, it is possible to relate macroscopic mechanical properties with chemical speciation and atomic scale structural information. This study focused on basalt fibers and their thermal stability, which is often described by a maximum temperature of use. However, values reported in literature cover a broad range from around 700°C to 980°C [1]. An earlier study reported changes in the mechanical performance of basalt fibers even at lower temperatures starting around 400°C [2]. With this background, during this study basalt fibers were investigated using X-ray fluorescence (XRF) and X-ray Absorption Near Edge Structure (XANES) spectroscopy at the K-absorption edges of three selected chemical elements - silicon, calcium and iron. The measurements were performed at beamline BL8 at the Synchrotron Light Research Institute (SLRI, Thailand) [3]. The absorption spectra of untreated fibers were compared with those of fibers which prior to the XANES experiments were heated at different temperatures. In the investigated temperature range up to 900°C, only the iron K-edge XANES data were measurably influenced by heating, which is probably related to oxidation processes and can be correlated with similarily occurring changes in mechanical performance. The actual investigations on basalt fibers will serve as starting point for future synchrotron based investigations on different inorganic fibers.

Literature

[1] B. Mahltig, Y. Kyosev, Inorganic and Composite Fibers; Woodhead Publishing, 2018.

[2] T. Overkamp, B. Mahltig, Y. Kyosev, J. Industrial Textiles 2018, 47 (5), 815-833.

[3] W. Klysubun, P. Sombunchoo, W. Deenan, C. Kongmark, J. of Synchrotron Radiation 2012, 19 (6), 930–936.

Manuela Niemeyer[1], Julia Demmer[2], Ekaterina Nannen[2], Anne Schwarz-Pfeiffer[1]
[1]Hochschule Niederrhein University of Applied Sciences, Department of Textile and Clothing Technology, Moenchengladbach, Germany
[2]Hochschule Niederrhein University of Applied Sciences, Department of Informatics and Electronics, Moenchengladbach, Germany

P39: Textiles meet Electronics – A new Interdisciplinary Educational Approach

To meet the challenges of digitalization and the resulting new potential for industry and research, traditional courses of study such as textile and clothing technology and electrical engineering need to invest more in interdisciplinary and digitally oriented collaboration.
We developed a Master course focusing on textile electronics that will enable students to understand and apply the fundamental technologies in the field of smart electronic textiles and to meet the challenges of industry and to be prepared for their future working life. The focus is aimed at master‘s students in electrical engineering and textile engineering.
The students will be able to learn and research in an interdisciplinary and project-oriented manner during their studies in order to be best prepared for the requirements of the industry for career starters in this field. First of all, industry representatives and associations were asked about the requirements for graduates. Subsequently students were also given the opportunity to contribute their wishes and ideas for the new specialization by means of a questionnaire. The aim is to provide students with a variety of practical knowledge and to give them the opportunity in online courses to acquire basic knowledge from the respective discipline. Finally, students will be able to apply the acquired knowledge in an interdisciplinary way in their own projects.

Mohammad Toufiqul Hoque, Silvana Haselsberger, Tian Benrui, Kristina Klinkhammer, Boris Mahltig
Hochschule Niederrhein, Faculty of Textile- and Clothing Technology, Mönchengladbach, Germany

P40: Dyeing behaviour of chitosan treated cotton and hemp fabrics – comparison of reactive dyes and direct dyes

Dyeing properties of cellulosic fibers can be modified by adding chitosan solution. Chitosan is a biobased polymer also described as antimicrobial agent, bio-degradable and not allergic to human skin. Chitosan is prepared by deacetylisation from chitin. With increasing degree of deacetylisation, the number of amino groups in the chitosan chemical structure increases. Because of the presence of amino groups, chitosan is soluble in water based acidic recipes. In the current study, chitosan was used in different concentrations as pretreatment for application of reactive dyes and direct dyes. Cellulosic fiber materials are normally prone to reactive dyestuffs but the excessive discharge of electrolytes in dyebath is undesirable. Improving affinity of cellulose towards acid or anionic dyes will significantly reduce the high concentration of electrolyte in dye bath. Therefore, introduction of amino groups (chitosan) into cellulose can improve substantivity towards acid dyes but also reactive dyes possible. In this work, two reactive dyes and two direct dyes in different hues were used to carry out the batch dyeing process in various shades. As textile materials cotton and hemp samples are used and pretreated with different recipes containing different chitosan concentrations. Dyeing properties of the chitosan treated samples are analysed and compared with untreated or raw samples.

Laura Tihon[1,2], Monika Fuchs[1], Liudger Dienel[2]
[1]Hochschule für Technik und Wirtschaft, Berlin Germany
[2]Technische Universität, Berlin, Germany

P41: Participatory product development for innovative smart garments

The aim of the dissertation is a process-oriented, participative product development methodology, which is agile, interactive and modularly responds to changes in the apparel market. For verification, the model is applied in practical use to the innovative field of smart garments using the example of intelligent, digitised bicycle clothing.The participatory product development is jointly researched at the department of clothing technology at the University of Applied Sciences Berlin (HTW) and at the Institute for Vocational Education and Training of the Technical University of Berlin (TU). The poster shows the first results of the case study in Vietnam and Indonesia.

Elisabeth Eppinger, Nele Winkler
University of Applied Sciences (HTW) Berlin, Germany

P42: Menstrual Underwear: Performance Requirements and Systematization for Developing Test Standards

Menstrual underwear is constructed of usually three to five layers of different synthetic fiber and cellulosic fiber based knitted fabrics. As we lack adequate test standards, our analysis of different products show that producers usually overestimate the performance. Also the construction of the edges and joints is a critical product feature and turned out to be the first part to leak during testing. The presentation addresses the question of how to characterize the performance requirements of menstrual underwear, acknowledging the huge diversity of the period phenomenon. Based on interviews and a survey with users, and an analysis of different available products, the study provides an initial systematization of performance requirements such as leak prevention, and comfort. The study also discusses different viscosities and amounts of liquids for testing the performance of periodic underwear in order to develop a systematic test that is reproducible and simulates the application of the products.

Parna Nandi, Dipayan Das
Department of Textile and Fiber Engineering, Indian Institute of Technology Delhi, Hauz Khas, New Delhi-110016, India

P43: Influence of mass fraction and reinforcement geometry on physico-mechanical, thermo-mechanical, and biodegradation behaviors of nettle (Girardinia diversifolia) reinforced PLA green composites

Green composites are becoming popular as a structural material for a variety of industrial applications. The growing need for a cleaner environment is driving the demand for green composites. The structural geometry of reinforcement, such as fiber-web, yarn, fabric, and so on, is important in determining the mechanical properties of biocomposites. In the current study, a set of biocomposite samples are produced from different mass fractions of nettle (Girardinia diversifolia) woven fabric and poly(lactic acid) (PLA) fiber-web, by employing compression molding. Thus, the physico-mechanical, thermo-mechanical, and biodegradation properties of prepared biocomposites are assessed. The biocomposite with equal mass fractions of nettle and PLA has the best mechanical properties while being lighter in weight. SEM images of the cryo-fractured surface show that the reinforcement is properly wettable. It has excellent thermal stability at temperatures as high as 300 °C. The DSC thermograms of the biocomposite with 50% reinforcement content indicate a significant influence on melting and crystallization behavior, and thus nucleation and crystallinity. It demonstrates notable dynamic mechanical behavior with the highest storage modulus, the highest loss modulus, and the lowest damping factor. After 35 days of burial in soil, it demonstrates excellent biodegradability.

On the other hand, a ‚tight' woven structure allows individual fibers to remain in close proximity, reducing entrapped air by reducing pore volume. Minimized void volume improves biocomposite mechanical strength, but biocomposites with higher reinforcement loading have significantly higher void content. Overall, the biocomposite prepared with an equal fraction of nettle woven reinforcement and PLA matrices shows great promise as a structural material for automotive dashboard panels and door panels.

Khosrow Rahimi, Oliver Rippel, Juliana Kurniadi, Tamas Haraszti, Dorit Merhof, Andreas Herrmann
DWI – Leibniz Institute for Interactive Materials, Aachen, Germany

P44: Computer-assissted identification of animal fibers

Cashmere is often adulterated through mixing with pristine or chemically modified wool and yak, since they are significantly cheaper. To protect companies against financial loss various methods have been proposed. Chemical methods (DNA analysis, MALDI-TOF mass, NIR-spectroscopy) are time consuming and can be applied only under special circumstances. In contrast, fiber identification based on fibers‘ surface topography is commonly accepted as a more reliable method. The cuticle hight, interval and pattern is often measured using optical microscopy and/or scanning electron microscopy (SEM). Yet, the reliability of these methods is extremely depending on the expertise of the operator. Many computer algorithms have been proposed to automate the process of image analysis and generate a more reproducible identification. However, up to what extent these methods are resistant against adulteration, is not well evaluated. Here, we have generated a large database of high resolution SEM from pristine and processed cashmere, wool and yak provided by a large set of distributers. The images have been used to train different deep learning and machine learning algorithms. The trained algorithms were used to identify weight ratios of different fiber types in a blend. The accuracy of identification was compared with conventional IWTO-58 standard and the potential sources for the discrepancy was identified.

Felix Reul[1,2], Abdolrahman Omidinia-Anarkoli[2], Laura De Laporte[2,3,4],Jacopo Di Russo[1,2]

[1]Interdisciplinary Centre for Clinical Research, RWTH Aachen University, Germany
[2]DWI - Leibniz Institute for Interactive Materials, Aachen, Germany
[3]Institute of Technical and Macromolecular Chemistry (ITMC), Polymeric Biomaterials, RWTH Aachen University, Germany
[4]Advanced Materials for Biomedicine (AMB), Institute of Applied Medical Engineering (AME), University Hospital RWTH Aachen, Center for Biohybrid Medical Systems (CMBS), Germany

P45: Hydrogel Fiber Spinning as Physiological Tissue Culture Substrate

From basic to pre-clinical research, biomedical progress (e.g., drug discovery) necessitates using tissue models in vitro. Despite technological advances in producing scaffolds mimicking tissues' biochemistry, suitable material platforms to rdepict the tissues' physical signals (i.e., mechanics) are currently limited. The stiffness of tissue culture plastic can partly match only bone or cartilage extracellular matrix (ECM) stiffness (~1-10 GPa), while available softer systems (i.e., hydrogels) usually do not represent the fibrous ECM structures. To address this gap, we have developed a process for producing synthetic hydrogel fibers with variable biochemical and mechanical properties by electrospinning. Poly (ethylene glycol) (PEG)-based hydrogel fibers are cross-linked without additional catalysts or reactants, rendering the process biocompatible and environmentally friendly. Furthermore, the fibers can easily be post-functionalized with relevant biochemical cues depending on the targeted tissue. The fibrous structure of the membrane ensures efficient nutrient and gas permeability and increases the surface-to-volume to support efficient cell attachment. Importantly, this alternative cell culture substrate requires a facile production of large quantities, which can be managed through continuous operation as well as the scalability.

In conclusion, this novel hydrogel fiber membrane meets the need for a versatile and adaptable tissue culture substrate, providing the desired biochemical, mechanical and physiological cues. This will significantly impact matching in vivo conditions for in vitro tissue models and potentially improve pre-clinical studies‘ efficacy.

Leonie Beek[1], Kai Klopp [2], Petra Ditsche[3], Musa Akdere[1], Matthias Mail[3,4], Thomas Gries[1], Wilhelm Barthlott[3]
[1]Institut für Textiltechnik der RWTH Aachen University, Aachen, Germany
[2]Heimbach GmbH, Düren, Germany
[3]Nees Institute for Biodiversity of Plants, University of Bonn, Bonn, Germany

P46: Bioinspired oil-water separation with hydrophobic textiles

Oil poses an immense risk of oil-spills in water bodies. There are several cleaning methods, but they have secondary harming impacts or require a high input of energy. Here, we present a new, sustainable method for oil-water separation. The goal was to identify a technical textile bioinspired by superhydrophobic plant surfaces, which are capable to quickly adsorb and separate oil from a water surface. In advance, more than 50 textiles were examined regarding their oil transport qualities. Three textiles were selected for deeper investigation of the volume flow of transported oil for five different oil types under (dis-)continuous conditions. The highest volume flow was found for a spacer textile with a monofilament as pile yarn with up to 0,5 l/h (heating oil, viscosity < 10 cP, width of the textile 6 cm). Another spacer textile with a texturized multifilament yarn showed higher volume flows for diesel fuel, waste oil, engine oil and bilge oil. Significant parameters for the volume flow are the oil viscosity, mesh alignment and the cover layers of the spacer textiles. The volume flow stayed constant over 3 weeks even under interrupted presence of oil on the water surface.

In conclusion, the indentified spacer textiles show similar probabilities to transport and separate oil from the water surface as the biological models and therefore offer the transfer of the biological phenomenon into a technical application. They can be easily scaled and integrated into different systems such as a Bionic Oil Adsorber (BOA) or industrial emulsion purification.

[1]Barthlott, W., Moosmann, M., Noll, I., Akdere, M., Wagner, J., Roling, N., Koepchen-Thomä, L., Azad, M. A. K., Klopp, K., Gries, T., Mail, M. (2020) Adsorption and transport of oil on biological and biomimetic superhydrophobic surfaces – a novel technique for oil-water separation – 15 pp., Phil Trans. Roy. Soc. A. https://royalsocietypublishing.org/doi/10.1098/rsta.2019.0447

[2]Beek, L., Ditsche, P., Akdere, M., Mail, M., Schmandt, E., Klopp, K., Gries, T., Barthlott, W. (2022) Separation of oil from water surfaces by bio-inspired technical textiles, Journal of Industrial Textiles, in Preparation.

Helga Ahrens-Wels
ITA RWTH Aachen University Germany

P47: Individualised clothing through textile component production

Approach:
Increased demand for individualised clothing is hindered by customers‘ refusal to pay the cost of one-off production.
This method of purposeful design, pattern construction and reworked grading steps as well as splitting the production steps can be a method to make individualised clothing possible at acceptable prices.
Method:

1. design: representation of the design differences (virtual model)
2. pattern construction: presentation of the optimised pattern in contrast to the conventional method
3. dimension tables: Approach visualised with the help of a configurator construction kit
4. production steps: Comparison of the conventional method to component production with calculation of production costs taking into account that there are no surpluses (unsold garments).

Conclusion:
Result of the calculation, (still open)
Advantages of individualised component production:

- Decoupling from the usual delivery rhythm
- Strengthening of the domestic textile industry
- Preservation of partner companies in low-wage countries
- Avoidance of overproduction
- Improved fit through individualisation and thus longer wearing time
- Wider clientele, even problem figures can be catered for

Disadvantages of individualised component production:
One disadvantage to mention is that this process is only advantageous for classic models,
Fashionable items with a short duration cannot be produced effectively in this way.

Robert T. Boich, Vadim Tenner
RWTH Aachen – Intitute for Textiletechonolgy, Aachen, Germany

P48: Development of a textile-based infrared heating technology to replace conventional heating systems in residential buildings.

Climate change is a dominant topic in politics and society. This issue is also reflected in housing construction and building renovation. According to the Federal Government, the building sector accounts for around 40 % of our final energy consumption. With this technology, it will be possible to replace fossil fuels for heating buildings.

Within the framework of the cooperation project, the manufacturing process for the series production of the innovative textile-based heating elements is being developed. The intended areas of application are mobile heating systems for existing buildings and mobile objects (e.g. marquees). It has already been proven that electrical energy can be converted into heat radiation with a high degree of efficiency using a flexible or brush-on heating paste (carbon-containing ink, dispersion). In order to exploit the potential of heating paste, the state of the art needs to be redesign and manufacturing processes (coating, packaging, integration into electrical systems) needs to be improved. Additional step is to focus heat emitting for example using via infrared radiation, which only heats objects in the room, but not the room air. This further increases the efficiency compared to conventional electric heating systems.

A modular plug-in system in frame construction is being developed that can be flexibly sized according to requirements and room geometry and is designed either as a standing or hanging system. In contrast to conventional, foil-based heating elements, the textile-characteristic properties of the carrier material are retained for the first time. This enables the heating elements to be made up into heating elements individually adapted to the room at economic conditions.

Robert T. Boich, Tobias Lauwigi
RWTH Aachen – Intitute for Textiletechonolgy, Aachen, Germany

P49: Textile-based sensor technology for human machine interface to operate orthosis and exoskeletons.

In the joint lighthouse project „ExoSense“ for international technology development, Korean and German partners are devloping textile-based, flexible, and adaptive sensor technologies for controlling orthoses and exoskeletons. This can enable precise,efficient and intuitive medical rehabilitation in the case of serious illnesses or after operations.

Currently, a major limitation in the field of exoskeletons and robotics for rehabilitation applications is the lack of performance of the sensor systems available today. Additionally, there is lack of the operation of the devices by the actual user or patient. Currently, the established rehabilitation systems are controlled by a therapist or operator. However, this limits the patient‘s control over their own movement. The new technology developed in ExoSense is designed to be scalable and will also form the basis for controlling complex exoskeletons in the future which applies to both the upper and lower extremities. For example, in rehabilitation applications, the force difference required to lift the knee can be measured and the support force can be regulated during therapy.

In Germany, the textile-based, adaptable sensor technology and the associated production process are being developed; on the Korean side, the sensors are being integrated into innovative, intuitively controllable rehabilitation devices and exoskeletons of the next generation. The system will also be embedded in a cloud solution to monitor patient data and therapy progress. The new technology platform is scalable and will also form the basis for controlling more complex exoskeletons in the future.

Kai-Chieh Kuo, Tobias Lauwigi
RWTH Aachen – Intitute for Textiletechonolgy, Aachen, Germany

P50: Textile implants in batch size 1 manufacturing.

Patient-oriented healthcare makes the individualization of medicine indispensable. This necessitates progress in patient individualization, especially through medical technology, in order to achieve the desired therapeutic success. From a technical and economic point of view, this is contrasted by the requirement for economical and reproducible production of products with a batch size of 1. These requirements can be met with innovative textile manufacturing processes. However, there is a lack of a fundamental understanding of product design, final product properties and intermediate manufacturing processes as well as appropriate tools for the implementation of these patient-individualized approaches.

The aim of the project is to implement a manufacturing process for patient-individualized textile implants in order to provide patients with a therapy that is ideally tailored to their needs. Implants for the treatment of aortic aneurysms serve as an application example, since this is a clinically as well as economically extremely relevant field of application for patient-individualized implant structures.

To achieve the project goal, approaches for geometric and structural patient individualization of textile implant structures were investigated. With regard to a continuous digital process chain, a database-supported virtual model for product design was developed. The interactions between the virtual product design, the process parameters of the manufacturing process and the resulting implant properties were determined both inline and offline. Suitable tools were developed and implemented for the inline acquisition of the process parameters. These acquired data are fed back into the virtual model database, thus continuously improving the accuracy and robustness of patient-specific design and production of implant structures. In this way, an economical and reproducible production of textile implants with a batch size of 1 can be realized, thus enabling a therapy that is optimally tailored to the patient.

Leon Pauly[1], Souvik Dey[1], Lukas Maier[2], Sibylle Schmied[1], Götz T. Gresser[1]
[1]German Institutes of Textile and Fiber Research (DITF), Denkendorf, Germany
[2]ICVT University of Stuttgart, Stuttgart, Germany

P51: New Method for Geometric Analysation of Knitted Fabrics

Quality Control is crucial when it comes to fine and technical knits. Digital Twins are on the one hand common in product development and are on the other hand necessary for mechanical or heat and mass flow simulations. For both purposes the exact geometry of the knitted loop is necessary for following processes. In order to parametrize digital twins of knitted fabrics the minimum of wale and course spacing is necessary. Manual extraction of loop parameters by counting and microscopic measurements is time consuming and little precise. A new method based on python toolbox OpenCV can automatically analyze wale and course spacing of knits. The algorithm is explained and validated on different fabrics. It is easy to adapt to new yarns and gauges than other manual or automatic methods. The developed method shows good agreement with common Fourrier-Transformation-based algorithms and manual measurements perspectively.

Stefan Peterek, Thomas Gries
RWTH Aachen – Intitute for Textiletechonolgy, Aachen, Germany

P52: InnoSpin - Development of an innovative spin head design for an increased efficiency and quality in wet spinning

In the InnoSpin project, a novel spinneret design was developed which can significantly improve the efficiency and fiber quality of existing wet spinning lines. The spinneret is intended to be a plug & play system that can be integrated into the spinning lines but does not requires significant changes in the process control. The innovative approach of the new nozzle design is to incorporate additional extrusion holes in the spinneret through which coagulation liquid is extruded in parallel with the spinning solution. This allows the deficit of conventional spinnerets to be avoided.
With the help of the novel nozzle design, coagulation liquid is extruded into the interior of the fiber in between the freshly coagulated filament bundle through additional extrusion holes. This coagulation fluid pushes away the trapped solvent, resulting in a more homogeneous solvent concentration in the fiber bundle and having a positive influence on the homogeneity of the fiber properties. This approach enables very high fiber qualities to be achieved even with spinnerets significantly larger than 12,000 spinning holes, thus increasing the productivity of the lines.

Philipp Quenzel, Thomas Gries
RWTH Aachen – Intitute for Textiletechonolgy, Aachen, Germany

P53: Material characterisation of unidirectional carbon fibre-based binder tapes

Dry fibre placement (DFP) is a subset of automated fibre placement (AFP) processes. During DFP, binder-fixated unidirectional tapes are automatically deposited onto the surface of the workpiece. Compared to prepreg-based AFP, the need for frozen storage and cost-intesive autoclave consolidation is eliminated. The preforms produced with the DFP are subsequently processed in liquid composite moulding processes, which enables the production of large components (by vacuum infusion) or high production rates (by RTM processes).

At present, however, little research has been done on the suitability of materials for processing in the DFP and on the associated process limits.

Therefore, a systematic method for the material characterisation of binder-fixated carbon fibre tapes is presented here. The aim of the analysis is to reduce the diversity of possible material combinations to a few characteristic clusters. For the characteristic tape clusters, type-specific process parameters and limits are then determined.

By defining material requirements and deriving material-specific guidelines for processing in the DFP process, the need for time-consuming and costly trial and error studies is avoided. By increasing the robustness of the process, productivity is also increased and production downtime is avoided. These findings enable material suppliers to offer DFP-optimised products and users of the technology to achieve efficient and flexible production.

Mathias Schmitz, Henning Löcken
RWTH Aachen – Intitute for Textiletechonolgy, Aachen, Germany

P54: Textile sporting goods produced from bio-based fatty acids

In the BIOTEXFUTURE innovation space, the transformation of the textile industry from petroleum-based to bio-based resources is being researched. In the BMBF project AlgaeTex, microalgae are used as a feedstock to develop man-made fibres from renewable resources for sustainable textile products. This development will make an essential contribution to sustainability and the German textile industry's future viability. The sustainability of the process chain for the production of the demonstrators is examined holistically and in detail. Polymers synthesised from bio-based fatty acids with the highest possible proportion of algae-based raw materials are used to produce melt-spun manmade fibres. These fibres are subsequently knitted into fabrics for high quality textile sporting goods. This is the foundation for the production of sporting goods from algae-based polymers.

The development of polymeric fibre materials is dependent on the availability of large amounts of raw material: industrial-scale melt spinning plants require large amounts of polymers. Smaller laboratory spinning lines require less amounts of raw material but the yarn properties cannot be easily compared to industrially manufactured fibres. Since polymers from bio-based feedstocks are usually only available at low amounts and high prices, a standardised method for the development of new bio-based yarns from sustainable feedstocks is needed. Chemical and rheological testing and process tests using micro extruders are conducted with small amounts of polymer. Subsequently, first melt spinning trials on a laboratory scale are carried out. Pre-industrial spinning trials are conducted and eventually, large industrial scale trials are taking place at the final stage.

Daniel Wolters[1], Maximilian Mohr, Maximilian Schirp-Schoenen[2], Thomas Gries[1]
[1]RWTH Aachen – Intitute for Textiletechonolgy, Aachen, Germany
[2]Institut für Strukturmechanik und Leichtbau der RWTH Aachen University, Aachen, Germany

P55: Aerogel nonwovens - A new high-tech insulation material for composite structures

The poster will present the latest research results of the Chrysomallos project. It will focus on the development of composite and sandwich materials with organic polyacrylonitrile (PAN) aerogel nonwoven obtained by the wet spinning process as well as reinforcing materials. PAN aerogel nonwovens precursors are produced using the nonwoven direct deposition wet spinning process and further processed into aerogel nonwovens by supercritical drying. These aerogel nonwovens will further processed into flexible, thermally stable and drapable high efficiency temperature insulation composites in a subsequent process step. The relationship between the filament properties, morphology and the influencing process parameters during wet spinning will be discussed as well as the challenges for an insulation composite in the aerospace sector will be shown.

Chrysanthi Oikonomidi[1], Maike-Elisa Ostheller[2]
[1]Aachen-Maastricht Institute for Biobased Materials e.V., Aachen, Germany
[2]Aachen-Maastricht Institute for Biobased Materials, Maastricht University, Geleen, The Netherlands

P56: Melt-spinning of biobased and biodegradable poly(ester amide) fibers as an alternative to conventional fossil-based

Biobased and biodegradable polymers have attracted interest, due to the microplastic pollution induced by petroleum-based polymers, and engineering them for fiber production can improve sustainability in the textile industry. Poly(ester amide)s (PEAs) exhibit enhanced mechanical properties due to the amide content and biodegradability triggered by the ester content. The aim of this research is to develop melt-spun PEA fibers for clothing applications that could potentially replace conventional fossil-based fibers, such as Polyethylene terephthalate (PET). The thermal, physical and rheological properties of novel PEA polymers of different grades have been investigated to assess their spinnability. The spinnable polymers were spun with a twin-screw micro-extruder laboratory-scale apparatus and upscaled using a melt-spinning pilot-scale plant, probing different draw ratios. The thermal and mechanical properties of the melt-spun fibers are thereof reported as well as the effect of the draw ratio on the crystallinity and performance of the fibers. The best-performing fibers demonstrated promising mechanical properties, close to the current benchmark of PET clothing specifications and were fabricated into knitted prototypes. Therefore, this research reports the melt-spinning of biobased PEA fibers in a pilot-scale spinning machine, with mechanical performance close to that of PET. This offers a sustainable solution for producing biobased fibers for clothing textiles that can replace conventional fossil-based.

Shubhi Sachan, Shubhi Sachan
New Delhi (India)

P57: Recycling of Post Consumer Textile Wastes

The textile industry in India is one of the country's oldest, having existed for several centuries. The worldwide textile sector emits more greenhouse gases than international shipping and air travel combined. Every year, the fashion sector produces around 53 million tonnes of fibre, 70% of which is discarded or burnt. According to the Ellen MacArthur Foundation, the fashion industry is responsible for 10% of world CO2 emissions yearly. That's more than the sum of all foreign flights and maritime shipping. Wastes are produced even during the making of textiles. We at MLI have collaborated with different companies and showcased them on various platforms in India and internationally.

Textile wastes are divided into pre-consumer and post-consumer textile wastes. At MLI, we find ways to work with these waste materials. These neglected materials are transformed into materials/products for everyday consumption like upcycled Floor mats, pillows, pillow covers, and yardages. Initially, the testing (like physical and chemical testing) and characterization of these waste materials are carried out to understand their properties, and accordingly, they are made into different products. In the poster presentation, we will focus on different ways in which textile wastes can be recycled and reprocessed to generate their maximum potential and converted to valuable products.

Marianna Halász[1], Gabriella Oroszlány[1], Orsolya Nagy Szabó[1], Stanislav Praček[2]
[1]Óbuda University, Sándor Rejtő Faculty of Light Industry and Environmental Protection Engineering, Institute for Industrial Product Design, Budapest, Hungary
[2]University of Ljubljana, Faculty of Natural Sciences and Engineering, Ljubljana, Slovenija

P58: The Effect of Yarn Residual Tension on an Unwinding Balloon

Yarn unwinding from a package is important in many textile processes. In textile production the yarn is being withdrawn from cross-wound packages in warping and weft insertion. During unwind the yarn tension is not constant, but it oscillates within some interval. This is especially noticeable in over-end unwinding from a static cross wound package, where the yarn is being withdrawn with a high velocity in the direction of the package axis. Even when the yarn is not strongly stressed, so that the tension does not exceed a few percent of the breaking strength, the yarn still can break sometimes. The goal of our contribution is to develop a mathematical model, which would permit to simulate the tension in yarn inside the package.

Matthias Salmen, Anette Höchst
procom, Germany

P59: Top 10 technologies in the cutting process and their impact on sustainability

This presentation deals with the issue of sustainability in industrial textile cutting. Textile cutting is the part of the textile production chain in which the individual parts of a textile product are cut out of the laid-out fabric on the basis of predefined contours. ProCom Automation is a supplier of automation solutions for the cutting and separating industry. ProCom has been developing control solutions for over 40 years, consisting of CNC and CAM software, high-quality hardware and an optimized IIoT solution for the cutting industry. With the adoption of Agenda 2030 in 2015, the question of how the technologies used can contribute to sustainability also arises for this sector. The focus here is on sustainable consumption and production patterns, resource-efficient use of energy and materials, and sustainable industrialization. In this presentation, we take a look at the state of the art, at current developments in control solutions and at future trend technologies. In doing so, their contribution to sustainability in textile cutting will be highlighted and the effects and optimization potentials on the textile value chain will be shown.

Hannah Kelbel[1], Felix Krooß[1], Wilko Heuten[2], Fabian Hemmert[3], Pirmin Kelbel[4], Anika Wotzka[5], Thomas Gries[1]
[1]RWTH Aachen University, Aachen
[2]OFFIS e.V., Oldenburg
[3]Bergische Universität Wuppertal, Wuppertal
[4]VISSEIRO GmbH, Berlin
[5]AWO Wohnen und Pflegen gGmbH, Oldenburg

P60: ZEIT - Experience Together, Participate Immersively through Tactile Supported Virtual Reality Immersion in Multi-User Scenarios

In this project, social connectedness across separated or distant people will be strengthened through mixed reality and social signals. The focus is on the emotional aspects of interpersonal communication, such as the transmission of joy and happiness, contentment, discomfort, stress and worry and also the feeling of touch or hug. The goal of the collaborative project is to research and develop a multimodal, target group-centered immersion technology as a system solution for bridging the gap between elderly people living alone and their relatives to answer the following question: How can immersive tactile stimuli in a VR environment be used to communicate interpersonal emotions over a distance? For this purpose, the experience that can be conveyed visually in a VR applications is supported by tactile stimuli on a large scale on the body. Programmable active textile actuators are used, which do not require complex mechanical actuators, can be adjusted according to the effect, can be integrated into digital systems and can be seamlessly embedded into textile household objects. To meet a rule-use fidelity for the target audience, textiles can be integrated into the arm and back of a chair and do not need to be worn. Processing responses to immersive stimulation using affective computing also enables the creation of a feedback system to other participants in multi-user scenarios. Furthermore, the integration into a familiar household object, the chair, makes the use of the overall system implicit and thus suitable for the target group.

Stefan Herrmann[1], Matthias Hesselmann[1], Maik Tepper[1,2], Hannah Roth[1,2], Matthias Wessling[1,2]

[1]Chemical Process Engineering AVT.CVT, RWTH Aachen University, Aachen, Germany

[2]DWI - Leibniz-Institute for Interactive Materials, Aachen, Germany

P61: Magnetic Mixed Matrix Membrane for Water Adsorption

The purification of gas streams by adsorption technology requires a cyclic regeneration of the adsorbent material. Regeneration technologies used are pressure and temperature swing adsorption; however, both processes feature a high, non-targeted energy input to operate the systems. To reduce the specific energy input for adsorbent regeneration, we aim to generate a targeted and local heat input directly at the adsorbent by magnetic induction. The developed system is scalable and adaptable for different purification processes by modifying the adsorbent selection. The project focuses on magnetic-inductively heatable hollow fibers with functional adsorbents for water removal and water recovery from gas streams.

The technical aim is to develop functional hollow fiber membranes combining the two functions of adsorptive water removal and magnetic-inductive heating by using mixed-matrix-membrane (MMM) technology. The magnetically heatable hollow fibers consist of a microporous hollow fiber membrane matrix with embedded magnetic nanoparticles (MNP) and functional adsorbent particles. In application, a wet gas stream for water removal is pumped through the hollow fiber so that the water adsorbs onto the adsorbent. For regeneration, the MNP are inductively excited with an alternating magnetic field. This causes the MNP to heat up and in consequence, the water on the adsorbent desorbs. This cyclic process is called magnetically induced temperature swing adsorption (MISA).

The research project enables an efficient and resource-saving process through targeted, local energy input with MISA. In addition, the hollow fiber-based system provides optimal flow conditions. The presented technology addresses relevant industrial and global humanitarian challenges, such as drying of compressed air to dew points below 0 °C and harvesting drinking water from ambient air in disaster areas or desert regions, respectively.

Funding and acknowledgements

The research project IGF-No. 21583 N of the research association of Forschungskuratorium e.V. is supported via AiF (“Arbeitsgemeinschaft Industrielle Forschungsvereinigungen Otto von Guericke e.V.”) within the promotion program of “industrielle Gemeinschaftsforschung” (IGF) of the federal ministry for economic affairs and energy on the basic of a decision by the German „Bundestag“.

Linda Steuer-Dankert, Sebastian Bernhard, Jessica Langolf & Carmen Leicht-Scholten
RWTH, GDI, Germany

P62: Managing Change and Acceptance of Digitalization Strategies

Digitalization is reshaping the production industry, resulting in the transfer of approaches from the Internet of Things (IoT) to enterprises, called “Internet of Production” in a Cluster of Excellence at RWTH Aachen University

- Thesis I: Changes are required regarding strategy development and implementation and have an impact on employees, organizational structures, and corporate culture
- Challenge: Digitalization approaches must be implemented in already existing corporate structures

-> Change is a critical element for the implementation of new approaches, as the risk of failure while establishing and securing organizational changes is seen between 40% and 70% [1, 2]

- Thesis II: Anticipation of the necessity of change and acceptance of change processes on employee side are decisive for success
- Research Focus: Investigation of the attitudes and mindsets in a corporate organization towards the implementation of digitalization in companies

-> Reflection of the acceptance of changes in the context of digitalization

Project funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany’s Excellence Strategy – EXC-2023 Internet of Production – 390621612

Nicole Preßler
Sächsisches Textilforschungsinstitut e. V., Chemnitz (Germany)

P63: Partially reinforced organic sheets based on rCF nonwovens

Nonwovens represent a promising option for the reuse of recycled carbon fibres (rCF), but have reduced mechanical properties compared to fibre reinforcements made from continuous fibres. The aim of the project „Partiell hochorientierte Organobleche" (engl. partially highly oriented organic sheets) is the development of component-specific organic sheets based on carded rCF-PA6 hybrid nonwovens. The base layer is partially reinforced with dry tapes of primary CF in a continuous compression moulding system. The organic sheets can be adapted to specific load cases and applications and have a high degree of prefabrication for following forming processes. A predominant challenge to be overcome in the development of the semi-finished products ist the locally different grammage in the layer structure. When pressing with flat tool surfaces, it leads to differences in the fibre volume content and an inconstant pressure profile across the width of the semi-finished product. This results in uneven impregnation qualities and lateral shift of the reinforcing textile structures due to flowing of the matrix into areas of low pressure. Various approaches are being investigated in the project to minimise these effects. These include the application of a pretension to the dry tapes, series of tests on the influence of pressing parameters (pressure, temperature, holding time), comparison of two PA6 systems with unequal viscosities and investigations on the influence of the sizing on the primary CF. The organic sheets produced are characterised by means of microscopic examinations and mechanical tests.

Elke Thiele, Corinna Falck
Sächsisches Textilforschungsinstitut e. V., Chemnitz (Germany)

P64: Wood-Textile-Folded Structures
Folded structures made of textile carrier with rigid applications

In a world that is constantly becoming more open, discretion and differentiation are becoming more and more difficult, but also more important. In areas of our working world, private and public life, discretion zones are necessary, which are created by setting up portable, self-supporting protective walls. The motivation for this project idea was to create walls which should be customisable in size and shape and foldable for transport. Applications can be seen indoors, e.g. foldable partitions for open plan offices, and outdoors, e.g. privacy screens for hazardous areas.
The goal was to develop wood/textile folded structures that can be set up temporarily for the purpose of noise protection, privacy protection or spatial delimitation. The wood/textile folded structures should be self-supporting and are characterised by a small packing volume and lightweight construction.
Multi-layer wood-textile composites were developed by using origami mathematics. The textile serves as a two-dimensional hinge for the finished construction. Depending on the technical requirements, a corresponding functional layer (e.g. wood or plastic elements) must be fixed to the upper side of the textile. The folding kinematics are determined by the geometry of the rigid wooden elements.
The project results are:

- Folding movements could be created by combining flexible textile materials with rigid wooden elements.
- With this composite material a self-supporting structure is possible.
- The option of installing acoustic elements makes it possible to increase sound absorption.
- Aesthetic design by combining textile, wood andorigami folding.

Nadine Liebig[1], Christine Hecker[2], Yvonne Joseph[2], Thomas Schulze[3], Kathleen Schütz[4], Michael Gelinsky[4], Heike Illing-Günther[1]
[1]Saxon Textile Research Institute (STFI), Chemnitz, Germany
[2]Institute for Electronic and Sensor Materials, TU Bergakademie Freiberg, Freiberg, Germany
[3]Thuringian Institute for Textile and Plastics Research (TITK), Rudolstadt, Germany
[4]Centre for Translational Bone, Joint and Soft Tissue Research, Technische Universität Dresden, Dresden, Germany

P65: Development of HAP bioceramics with anisotropic pore structure for bone tissue engineering

(1) Introduction
Due to their chemically similar composition to the mineral phase of natural bone, calcium phosphate-based (CaP) bioceramics can serve as a framework for controlled bone regeneration, provided they have the appropriate porosity. However, limitations of currently available materialsare an isotropic structure, low mechanical strength or complex manufacturing processes.
(2) Objectives
In this work, a new relatively simple method is presented that overcomes the limitations of already available CaP bioceramics. Cellulose-calcium-phosphate hollow fibers form the basis for the production of an anisotropically structured.
(3) Materials and Methods
The CaP cellulose fibers (Alceru®) were arranged in parallel, coated with CaP suspensions or infiltrated as a bundle. Bundling was done using textile Kemafil® technology. In a subsequent sintering process >1000 °C, the cellulose components were burned out and an anisotropically structured fiber composite was formed.
(4) Results
Cell biological investigations showed that bone-forming cells already completely enclose the structures after 14 days. The compressive strength of the materials, with a porosity of between 45 % and 65 %, is up to 25 MPa higher than that of spongiosa, depending on the material variant.
(5) Conclusion
After the high level of biocompatibility has been demonstrated, the suitability of the materials is to be demonstrated in a small animal study. Due to the high porosity of the materials, they are also suitable as active ingredient carriers. Further development work should serve to optimize the fiber matrix composite.

Jens Mählmann, Nadine Liebig
Saxon Textile Research Institute (STFI), Chemnitz, Germany

P66: Multi-adaptive low energy greenhouse system - Development of a thermal blind for greenhouses from spacer fabrics

(1) Introduction
Awareness of a sustainable lifestyle is growing continuously, and with it the demand for regional products, especially from agriculture. In Germany, preference is increasingly being given to domestic agricultural products. This leads to conflicting goals, because a year-round supply would require the conversion of today's 98 % dominant outdoor cultivation to large-scale energy-intensive greenhouse horticulture.
(2) Objectives
The innovative roof system ensures optimal year-round growing conditions for arable crops with minimal energy consumption. The individual roof elements can be assembled in modules. The system features a multi-zone and multi-layer structure.
(3) Materials and Methods
Warp knitted spacer structures were used for the outer insulation material. With their air-guiding layer, the 3D textiles suggested a good insulating effect.
(4) Results
Since the mechanisms of heat and mass transfer vary depending on the flow conditions inside and at the edges of the spacer fabrics, different results on heat transfer were to be expected in the tests despite the small differences in thickness of the test samples. This assumption was not confirmed.
(5) Conclusion
With the combination of the Lean-to greenhouse type and state-of-the-art functional textiles, a new type of greenhouse has been created that represents an important alternative to conventional industrial greenhouses such as Venlo greenhouses, in the wake of resource scarcity.

Nadine Liebig[1], Reinhard Helbig[1], Christian Schulze[2], Paul Lindner[2], Frank Borrmann[3], Sebastian Prochnow[4], Thomas Biebig[4], Matthias Ospel[5], Matthias Witte[5]
[1]Saxon Textile Research Institute (STFI), Chemnitz, Germany
[2]Gesellschaft für Akustikforschung Dresden mbH (AED), Dresden, Germany
[3]Baltic Marine Consult GmbH (BMC), Rostock, Germany
[4]Rostock Port GmbH, Rostock, Germany
[5]University of Rostock, Rostock, Germany

P67: Development of a passive sound insulation system using acoustically effective textiles

(1) Introduction
Living in direct proximity to waters testifies to a high quality of life and is often described as an increase in comfort. This, and above all the increased shortage of housing, offers a high incentive for new housing developments in adjacent port areas. However, the proximity to ferry ports and, in particular, roll-on roll-off ports leads to considerable noise pollution for residents.
(2) Objectives
The aim of the joint project is to develop a mobile, textile-based sound absorber for the port area, especially at roll on roll off transshipment points (RoRo transshipment). Acoustic as well as textile-physical properties are specifically adjusted and adapted to the prevailing environmental conditions.
(3) Materials and Methods
The textile sound absorber was made of 3D spacer textiles. These have a good acoustic effect. To increase this effect, the 3D spacer textiles were equipped with a weather-resistant coating.
(4) Results
It has been confirmed that an optimal absorber allows sound to penetrate completely and then attenuates and dampens it. Since the wavelength of the incident sound depends on its frequency, absorbers must be specifically adjusted to a frequency band to be attenuated.
(5) Conclusion
Now that the high acoustic effect of the 3D spacer textiles has been demonstrated on a demonstrator wall, a mobile textile-based sound absorber is being developed for the port area.

Nadine Liebig, Elke Thiele
Saxon Textile Research Institute (STFI), Chemnitz, Germany

P68: Carbon-supported, multifunctional heating, reinforcement elements for parking garage access roads

(1) Introduction
The roadways of parking garages and underground parking lots are highly stressed components that are often made of reinforced concrete. In addition to load transfer, they are exposed to a wide variety of media such as water, de-icing salts and chlorides. The entry of chlorides is particularly critical. Underground parking garages built in the last 30 to 50 years sometimes show considerable damage as a result of chloride-induced reinforcement corrosion, which all too often confronts operators with the decision between renovation and demolition.
(2) Objectives
In this research project, a multifunctional solution approach was pursued for the production of a non-metallic reinforcement structure made of carbon fibers for simultaneous use as surface heating.
(3) Materials and Methods
The multifunctional reinforcement elements are designed as warp knitted fabrics consisting of carbon fiber rovings. The warp knitted fabrics are used for reinforcement and, due to the electrical conductivity of the carbon fibers, also act as a highly efficient carbon heater.
(4) Results
The use of low voltage ensures uniform heating and warming of the road surfaces. In the shoring, it was important to position the knitted fabrics as close to the surface as possible. The deeper the heating cables are embedded in the roadway, the longer the heating time until the defrosting surface temperature of around +3 °C is reached. By integrating snow, ice sensors and a corresponding control system, the surface heating can be operated according to demand.

Ralf Lungwitz, Heike Illing-Günther
Saxon Textile Research Institute, Chemnitz (Germany)

P69: UV curing: an ecofriendly and resource efficient technology for textile industry

In times of increasing energy costs and a growing environmental awareness the textile finishing and coating tends to modern, ecological, energy and cost efficient technologies. UV curing is a well-known and established technology in many industrial applications such as graphic, wood, paper or varnish sectors.

The work shows the application and potential of UV LED curing in the field of textile coating, 3D printing and fiber composites. The advantages compared to the currently used methods are presented.

Marcel Hofmann[1], **Florian Wafzig**[2]
[1]Sächsisches Textilforschungsinstitut e.V., Chemnitz (Germany)
[2]Fraunhofer-Institut für Chemische Technologie (ICT), Pfinztal (Germany)

P70: VliesSMC – Processing of recycled carbon fiber nonwovens in sheet molding compound

STFI e.V. and Fraunhofer ICT are investigating new ways to process rCF-nowovens. For this, a new SMC technology was set up at the Fraunhofer ICT. The processabilty of rCF-nonwovens in the SMC process chain was successfully demonstrated in the project.

Within the research project VliesSMC, the suitability of different types of nonwovens based on recycled carbon fibers (rCF) for processing in the SMC process chain was investigated. In particular, open questions regarding the different textile manufacturing processes, production and handling of SMC semi-finished products, as well as the flowability in the compression molding process are addressed.

The following research topics were pursued in the project:

- Development of adapted nonwovens made from recycled carbon fibers
- Influence of different web formation methods on the impregnation quality and the flowability of the SMC semi-finished product
- Equipment and process development with the aim of automated processing of rCF-nonwovens in the SMC process chain
- Limits of part complexity in the molding process of rCF-SMC depending on the achievable fiber volume content
- Cost analysis and economic feasibility study of the VliesSMC recycling process

A project-accompanying committee, which includes material and equipment manufacturers as well as processing companies, ensured that the developments are relevant to industry and that they can be directly implemented.

The IGF project „VliesSMC“ (No. 21124 BG) of the research associations DECHEMA Society for Chemical Technology and Biotechnology e.V. and Forschungskuratorium Textil e.V. was funded by the Federal Ministry for Economic Affairs and Climate Action through the AiF as part of the program to promote industrial community research (IGF) funded by a resolution of the German Bundestag.

Patrick Engel
Saxon Textile Research Institute, Chemnitz (Germany)

P71: Sustainable Sleeping

The research aims to develop a marketable insulation layer made of bio-based and vegan fibre materials that can be used in outdoor applications such as jackets, blankets and sleeping bags and that have the following properties;

- bio-based and vegan filling material
- high insulating effect, bulking capacity or resilience
- moisture management, washability and outdoor use
- weight, pack size corresponding to the market
- reasonable product price, wearing comfort, formability

For the ethically questionable plucking of downs and feathers, vegan alternatives are to be offered which, in contrast to solutions made of synthetic fibers, can be produced in a bio-based manner. High Fill Power values represent a very efficient material that contributes a large volume and high recovery capability through a relatively low basic weight. The insulation layer made of bio-based fiber material to be used for sleeping bags should be able to realize a comfort temperature of 5 - 10 °C. At the same time, moisture absorption must be ensured.
Viscose fibres are known for their high absorption, but must be modified to prevent the formation of waterlogging, which in turn would significantly impair wearing and sleeping comfort. Proof of the insulation material‘s resistance to washing must also be provided under this aspect. After the insulation layer has been subjected to several washing cycles and dried, a voluminosity sufficient for insulation must be maintained.

Heike Metschies
Sächsisches Textilforschungsinstitut e.V. (STFI)

P72: Rail joint - Prefabricated elastic joint with textile reinforcement for streetcar tracks

In tramway track construction, the closed superstructure has developed into a fundamental design principle. Special demands are placed on it, as it is used by individual and rail traffic as well as cyclists and pedestrians. Resulting construction joints must be watertight and absorb the different movements of the rail tracks and the asphalt platform area.

The project investigated the possibility of modifying the previous steps in joint production in rail track construction, making up reinforced joints in advance and thus shortening the construction time. With the use of textile reinforcements as a connecting element between the prefabricated joint and the road surface asphalted on site, the aim is to achieve a long service life for the entire system in order to reduce the life cycle costs compared to the previous joint systems.

The development and testing of textile anchor elements - which are integrated into the joint on one side and form a bond with the asphalt surface during installation - was the task of the STFI. The knitted reinforcements were made of high-temperature resistant materials and integrated load-bearing bars. Two and three-dimensional prototypes were developed and examined in the laboratory and on a test track.

Heike Metschies
Sächsisches Textilforschungsinstitut e.V. (STFI)

P73: Facade panel with structured surface

Due to their multiple functions and occupying surfaces, facades take on a special role in urban agglomerations in terms of energy efficiency and sustainability. This results in corresponding building physics requirements for heat, moisture and sound insulation. The research project aimed to develop facade panels that meet aesthetic and material requirements in a very flexible way through additive manufacturing. They also contribute to reducing NOx levels by functionalizing the surface. The basic structure of the facade panel consists of a thin carrier plate with integrated alkali-resistant textile connection reinforcement. The top layer of the facade panel was to have an ornament-like surface, which was to be applied additively by an existing pressure gantry system for concrete printing. In this case, the face concrete partly consists of a TiO2-modified formulation.

The textile reinforcement concept of the project envisages providing three-dimensional reinforcement structures for concreting. These are either manufactured as three-dimensionally built-up flat goods, so-called spacer fabrics, directly on the machine in one work step or alternatively are built up step by step into 3D lattice elements by forming or form-fixed coating from flat and two-dimensionally manufactured textile lattice structures.

Tobias Petzold, Sarah Lysann Zedler
Sächsisches Textilforschungsinstitut e. V., Chemnitz (Germany)

P74: Multifunction 3D printing on textiles

The digital functionalization of textile surfaces with 3D printing technology uses different extrusion processes with small single nozzles. During the manufacturing process, these nozzles can process only one material at the same time. For example, only one hard or soft material is applied to the textile. If both materials are required for the additive manufacturing process, 3D printers with two nozzles are used, or the material has to be replaced in between. The result are expensive and long set-up times. Simultaneously, there is no possibility of grading the properties. This limitation can be solved with the use of two material conveying units and one mixing tube. This enables a variable and simultaneous combination of different materials.

The aim of the project „Variably adjustable material application using 3D printing to combine different functions on textile substrates“ was to generate several functional modifications on a textile in one process step. The approach was to develop a 3D printing process for textiles in which different functions were generated within one print pattern. In this process, two materials were applied to textile subtrates via a variably adjustable mixing ratio in the 3D printing process. This made it possible to apply the desired functional properties to the textiles exactly where they were needed. Various demonstration samples (work gloves, functional socks) were successfully finished with different functional areas (increased abrasion resistance, hydrophobicity, hard/soft areas, anti-slip and reflective properties) using 3D printing technology. The advantage over conventional processes, such as screen printing, can be seen in the resource-efficient production of individualized small quantities.

Sedat Kumartasli, Seda Ünal
Polyteks R&D Center, Bursa (TURKEY)

P75: Investigation of some mechanical properties of continuous Glass Fiber/PP Fiber Composites

Today, fiber-reinforced thermoplastic composite materials are widely used due to their superior properties such as fracture toughness and recyclability and energy absorption. In addition to these superior properties, its high melt viscosity is its weakness. To overcome this problem, it is necessary to mix the reinforcement fiber homogeneously with the matrix in the solid state. In this study, different yarn production methods, yarn structures and properties are given in detail. In addition to hybrid yarn production methods, the effect of process parameters on yarn structure and properties is characterized. The mechanical properties of thermoplastic composites to be prepared using 50/50% continuous glass fiber (CGF) / Polypropylene (PP) hybrid yarns were investigated. CGF/PP hybrid yarns were produced, woven and then transformed into thermoplastic composite test plates using a hot press. Impact tests were used to investigate the mechanical properties of the composites.

Jason Zografou[1], Alexander Paulheim[2], Karolina Jagla[1], Heuvel Flemming[2], Sophia Gelderblom[1], Bayram Aslan[1]
[1]TFI – Institut für Bodensysteme an der RWTH Aachen, Aachen (Germany)
[2]wfk - Cleaning Technology Institute e.V., Krefeld (Germany)

P76: Inverse streamer corona discharge for dry disinfection of textile floor coverings with electrode pile

The aim of the research project is the dry disinfection and deodorization of textile floor coverings by means of inverse streamer corona discharge. For this purpose, textile floor coverings with 3D electrodes of conductive threads integrated in the base and wear layer (electrode pile) as well as a cleaning device adapted to such floor coverings for the generation of streamer corona discharges are developed. For the development of the cleaning device, a high-voltage power supply and an electrode of suitable geometry (shape and size matched to a vacuum cleaner, energy requirement of the high-voltage source) as well as a supply and exhaust air system are integrated into a brush vacuum cleaner. As before, dirt removal is carried out by brush vacuum cleaner in a single operation. Furthermore, suitable process parameters (e.g. voltage and frequency of the alternating voltage, electrode geometry and distance) for an efficient dry disinfection and deodorization of textile floor coverings with electrode pile are investigated. This ensures that dry disinfection and deodorization of the textile floor covering is achieved through the entire wear layer up to the base layer by an inverse streamer corona discharge.
Both manufacturers of textile floor coverings (mainly SMEs) and cleaning service providers (mainly SMEs) benefit from this project results, as an innovative process for dry disinfection and deodorization of textile floor coverings with electrode pile is being developed as part of daily maintenance cleaning.

The IGF project 21108 N/2 of the Forschungsvereinigung Forschungskuratorium Textil e.V., Reinhardtstraße 14-16, 10117 Berlin is funded by the AiF within the framework of the program for the Promotion of Industrial Joint Research and Development (IGF) by the Federal Ministry for Economic Affairs and Climate Affairs (BMWK) based on a resolution of the German Bundestag.

Christian Goetz[1], Florian Guttenbacher[1], Sophia Gelderblom[1], Bayram Aslan[1], Sofia Andrés-Zapata[2]
[1]TFI – Institut für Bodensysteme an der RWTH Aachen e.V., Aachen (Germany)
[2]FiW – Forschungsinstitut für Wasserwirtschaft und Klimazukunft an der RWTH Aachen e. V., Aachen (Germany)

P77: Textile curved sieve: filter system for solids separation from wastewater streams with low-maintenance cleaning concept based on structured pile textiles with defined separation behavior

Filters for solids separation are successfully used in wastewater-technology. The cleaning units currently in use, such as curved sieves made of welded stainless steel, are often custom-made products with high acquisition and maintenance costs due to the individual requirements.

The aim of the project was to develop a cost-effective textile filter with a pile structure. The discontinuous filter process was to be converted into a continuous filter process to enable low-maintenance and automated cleaning when separating solids from liquids in curved sieves.

At the beginning, the requirements were determined regarding the mechanical load capacity and the filter properties. From this, the materials to be used for the textile filter and initial approaches to the design were derived.

Tufting technology was used to create the pile structure, as it is variable and cost-effective, compared to other textile processes for producing three-dimensional-structures. Thermobonding (calender) was chosen to consolidate the pile structure, since the primary backing must remain permeable to retain the filter properties. The produced textile filters were then tested, evaluated, and systematically developed on an adapted test rig regarding the defined requirements.

In the course of the project, it became obvious that the textile filter constructions did not achieve the defined project requirements of a continuously moving filter textile and that the high mechanical loads promoted the fiber discharge to be avoided. Thereupon, textile filter constructions for a static filter process were pushed and a special focus was placed on pile fixation by means of a calender.

The IGF project „Textile curved sieve: filter system for solids separation from wastewater streams with low-maintenance cleaning concept based on structured pile textiles with defined separation behavior“ 21147 N of the Research Association Forschungskuratorium Textil e.V., Reinhardtstraße 14 – 16, 10117 Berlin was funded by the Federal Ministry of Economic Affairs and Climate Action via the AiF within the framework of the program for the promotion of joint industrial research and development (IGF) on the basis of a decision by the German Bundestag.

Christian Goetz, Dirk Hanuschik, Sophia Gelderblom, Bayram Aslan
TFI - Institut für Bodensysteme an der RWTH Aachen e.V., Aachen (Deutschland)

P78: Double-sided tufted loop structures made of metal yarns for use in heat exchangers for domestic ventilation

For energy reasons, buildings are being built more and more airtight, which causes moisture to collect in the room. This increases the risk of mold growth, which can be prevented by controlled living space ventilation. With integrated heat recovery, exhaust air heats the cold fresh air.

The aim of the project was the cost-effective production of air heat exchangers with improved properties in terms of acoustics, compact dimensions, flexibility, simplified flow guidance and a simple cleaning concept.

The solution was to use a three-dimensional textile made of thermally conductive yarns as a heat exchanger element. The tufting technology used to produce the textile structure enables the shortest possible connection between the pile loops on both sides of a plane separating the two air streams.

In a machine development, a conventional tufting machine was modified to create a loop structure on both sides of the primary backing. For the thermal evaluation of the double-sided loop structures, a test rig was used that was developed and built for this purpose. The quantified thermal conductivities of the manufactured samples were used to dimension tufted structures for a heat exchanger for residential ventilation. Finally, a concept for the integration of the textile heat exchanger element in a roller shutter box was created.

The results presented originate from the work on IGF research project 20540. This is funded by the Federal Ministry for Economic Affairs and Climate Action via the AiF as part of the programme to promote joint industrial research and development (IGF).

Florian Mews[1], Heiko Matheis[2], Lukas Schüller[1], Guido Grau[2]
[1]TFI – Institut für Bodensysteme an der RWTH Aachen e.V., Aachen (D)
[2]DITF – Deutsche Institute für Textil- und Faserforschung Denkendorf, Denkendorf (D)

P79: Data-supported efficiency enhancement in the development of textile products through experimentable digital twins using the example of tufting

The development of new tufting products is associated with high material, time, personnel and cost requirements. Typical development times for new products take between 6 for known materials and up to 12 months for unknown materials. Product development is usually empirically based and builds on the know-how of long-time employees. They create new products from information on customer requirements, materials, machinery and the necessary production steps. This expert knowledge is neither stored nor retrievable or reproducible. Due to the shortage of skilled workers and the age structure of the workforce, the long-term transfer of knowledge is at risk. The development of Experimentable Digital Material Twins (EDMT) and Process Twins (EDPT), as well as the use of AI (artificial intelligence) methods, enable digital product development. For this, all material, process and product parameters relevant to the process are recorded. AI methods then help to validate known and even identify previously unknown dependencies between these parameters and to elaborate proper machine settings. Such data-supported information and knowledge acquisition makes it possible to simulate the development of new products in advance and to use physical and human resources more efficiently. A reduction in development costs of up to 60% is expected. Product development can be accelerated and made more flexible and economical even for small batch sizes.

The goal is to develop Experimental Digital Material Twins, which, together with the EDPT and the use of AI, enable a significant increase in resource efficiency.

Ansgar Paschen[1], Reimer Karstens[2]
[1]TFI – Institut für Bodensysteme an der RWTH Aachen e.V., Aachen (D)
[2]wfk – Cleaning Technology Institute e.V., Krefeld (D)

P80: Akustomechanische Reinigung textiler Bodenbeläge auf Basis metallischer Helixgarne

Due to their construction, textile floor coverings have many advantages, such as heat-insulating, sound-reducing, slip-reducing, accident-reducing as well as fine dust and allergen-binding properties. Nevertheless, there is a trend to increasingly install resilient floor coverings, as they are more efficient to clean and also have a longer service life. The quantities of water currently required for textile floor coverings, especially for basic cleaning and local stain removal, lead not only to long drying times but also to irreversible damage. Therefore, textile floor coverings often have to be replaced before mechanical wear occurs. The aim of the research project is to use specially developed helix yarns (metal yarns wound with polyamide yarns) to create innovative textile floor coverings that have a service life comparable to that of resilient floor coverings. By developing a new cleaning process based on radial shock waves that interact with the metallic core of the helix yarns, these innovative textile floor coverings can be cleaned acousto-mechanically as efficiently as elastic floor coverings. Manufacturers of textile floor coverings, building cleaners and building operators benefit from the research results.

Louisa Zobel[1], Stefan Schumacher[2], Dirk Hanuschik[1], Karolina Jagla[1], Sophia Gelderblom[1], Bayram Aslan[1], Christof Asbach[2]
[1]TFI – Institut für Bodensysteme an der RWTH Aachen, Aachen (Germany)
[2]IUTA – Institut für Energie- und Umwelttechnik e.V., Duisurg (Germany)

P81: Development of long-term stable filters with low pressure loss based on electrically conductive tufted structures for use in room air purifier

Due to increasing air pollution and events such as the ongoing COVID pandemic, the need to improve indoor air quality and reduce emissions through air filtration is steadily increasing. Currently, filtration devices mainly use electret filters, which are characterised by a high separation rate combined with a low pressure loss. These filters lose their non-regenerative charge with increasing service life, which reduces the filter effect. In addition, the filters cannot be cleaned. Therefore, they must be replaced regularly.
The aim of this research project is to develop filter structures that have a constantly high filtration effect due to a permanent charge and which are easily cleanable.
For this purpose, a textile 3-D structure is being developed with fibres that are arranged parallel to the direction of air flow. Insulating as well as electrically conductive yarns are incorporated into this 3D structure so that islands with differently charged electrical potentials can be created by applying a voltage in the surface. The tufting technique is used as manufacturing method, in which parameters such as the pile density in the longitudinal and transverse directions, pile height or offset pattern can be efficiently varied. The functional relationships between charge fields, tuft column and reciprocal charging are being analysed.
The results presented originate from the work on IGF research project 21783. This is funded by the Federal Ministry for Economic Affairs and Climate Action via the AiF as part of the programme to promote joint industrial research and development (IGF).

Louisa Zobel, Ansgar Paschen, Sophia Gelderblom, Bayram Aslan
TFI – Institut für Bodensysteme an der RWTH Aachen, Aachen (Germany)

P82: Method for an alternative pile fixation of tufted fabrics for a recyclable textile floor covering

Tufted textile structures require a finishing step for filament and pile fixation before they can be used. For carpeting, a chalk-filled SBR latex is usually used to bond the yarn and filaments to the backing. This type of pile fixation makes it difficult to recycle the different polymer materials used in the tufted textile structure.
The aim of this research project is to develop a valid process for the pile fixation of tufted structures that has improved recycling properties.
The approach is the mechanical fixation of the pile yarn by controlled shrinking of a shrinkable primary backing after the tufting process. By generating a controlled shrinkage through thermal energy, shrinkage forces are triggered in the primary backing, resulting in frictional forces between the primary backing and the pile yarn, which serve to mechanically bind the yarn into the primary backing.
For this purpose, various woven and nonwoven primary backings were developed and realized regarding optimum shrinkage properties and pile extraction force. The primary backings were tufted, shrunk and tested. The focus of the investigation was the influence of the primary backing, the tufted yarns, the tufting construction and the shrinking process on the pile fixation. The principle of mechanical pile integration could be proven by the investigations carried out.
The results presented originate from the work on IGF research project 21336. This is funded by the Federal Ministry for Economic Affairs and Climate Action via the AiF as part of the programme to promote joint industrial research and development (IGF).

Michael Sturm[1], Marcus Krieg[1], Ilkka Kilpeläinen[2]
[1]Thüringisches Institut für Textil- und Kunststoff-Forschung Rudolstadt e.V., Rudolstadt (Germany)
[2]University of Helsinki, Helsinki (Finland)

P83: Investigations for the use and recyclability of the ionic liquid [MTBDH][AcO] as a solvent in air-gap-wet spinning process

Recyclability is a crucial criterion of a solvent in a continuous production process. In this study the recyclability of 7-Methyl-1,5,7-triazabicyclo[4.4.0]dec-5-ene acetate ([MTBDH][AcO]), an ionic liquid (IL), that is an advanced solvent for Lyocell process, is investigated. A series of 21 consecutive cellulose dissolving and spinning trials via dry-jet wet spinning was conducted with the same batch of solvent. In the spinning trials, the cellulose was regenerated into water consisting spinning bath. The solvent was recycled by removing the water from the spin bath via distillation in reduced pressure. Due these drastic changes in the water content of the IL during the whole process, the hydrolytic stability is an important aspect to assess the recyclability of the IL and viability of the whole process. The chemical composition of the IL was monitored by means of NMR spectroscopy. Although there was an increase of hydrolysis products, cellulose could be dissolved constantly and spun to obtain staple fibers. However, the spinning behavior deteriorated slowly along the additional cycles, along with a measured increase in zero-shear viscosity of the spinning dope. However, the physical properties of the obtained fibers were barely influenced by the changes of the ionic liquid.

Pulkit Mishra[1], Patricia Martin[1], Mandy Weber[1] , Andreas Heinke[2]
[1]Textilforschungsinstitut Thüringen-Vogtland e.V. (TITV), Greiz, Germany
[2]Institute of Biomedical Engineerin (IBMT), TU Dresden, Germany

P84: Re-positionable textile EMG electrodes for physiotherapy in mobile rehabilitation

Outpatient rehabilitation is an important pillar of our healthcare system. Integrating excercises into everyday life enables more intensive training and leads to rehabilitation success more quickly. In order to be able to perform exercises independently in addition to regular physiotherapy sessions, the proper execution should be monitored. To be independent while training, video recordings should be avoided, instead sensors should measure the movements. Software evaluates the sensor data so that individual feedback is possible and, in combination with gamification elements, the movement can be adapted to the therapy requirements. The research project iTex-4-MoRe – intelligent textiles for physiotherapy in mobile rehabilitation aims to develop comfortable sensor technology. These are integrated into sportswear and allow online qualitative control of excercises.

In this context, textile EMG (electromyography) dry-electrodes are to measure not only the quantity of muscle activity but also the quality of muscle coordination. So far, it requires surface wet electrodes to be placed professionally on the skin. Re-positionable textile electrodes were fabricated from metallized yarns coated with human-toxicologically safe polymers via a nanoscale adhesion promoter layer to withstand stress over many hours of exercise and ensure positioning accuracy. Dry-electrodes are compared and evaluated using both 'Electric Skin' and in-vivo models. Thanks to the development, sportswear with EMG electrodes will be part of any physiotherapy in the future. This research can also provide support for fitness enthusiasts and competitive atheletes.

We thank the BMWK, the AiF and the DECHEMA for financial support as well as our project partner, the IBMT, for cooperation.

Annika Gambke, Antje Krahmer, Andreas Neudeck
TITV e.V, Greiz (Germany)

P85: New way s to generate flexible, reliable and high functionalized conducting structures on textiles

Existing functional printing and coating technologies for textile substrates reach their limits due to limited amounts of pigments, which can be incorporated. Corresponding samples show a lack of flexibility and abrasive resistance. In recent studies the powder coating technology developed by TITV Greiz generates high conducting structures on textiles with surface resistance less than 0.1 Ohm per square, due to high content of functionalized particles between 60 up to 80 %. Such highly metal particle loaded powder coatings on textile substrates yield to extremely flexible and mechanically resistant conductor tracks. The coating can be applied planar as well as in a desired local structure. The approach of powder fixation using laser radiation offers the possibility to work based on digital datasets especially for more complex coating structures. It is therefore competing with existing conductive coating technology like digital printing as well as screen printing. Moreover, cold plasma spraying, which is also part of a current research interest, can be used to generate highly conductive textile coatings as well. It can be achieved an area-wide as well as selective metal deposition functionalization. This technology is competing with the powder coating approach in terms of obtained surface resistance of the paths around 0.2 Ohm per square. Powder coating as well as cold plasma spraying represent promising technology for flexible, textile based circuit boards and sensors with high functionalized and reliable conductive tracks. Answering to customer needs, the next generation of conductive Smart Textiles will contain such technologies.

Katja Dutzi[1], Nadja Regner[1], Nico Vieweg[1], Andreas Steiger[2], Helmar Abele[3], Cigdem Kaya[3], Thomas Stegmaier[3]
[1]TOPTICA Photonics AG, Gräfelfing (Germany)
[2]Physikalisch-Technische Bundesanstalt (PTB), Berlin (Germany)
[3]Deutsche Institute für Textil- und Faserforschung (DITF), Denkendorf (Germany)

P86: Thickness Gauging of Polymer Coatings on Knit Fabrics using Fast Terahertz Time-Domain Spectroscopy

Thickness gauging of high-tech textiles and textile coatings is challenging as fabrics are structured, flexible and compressible materials. Coating materials can penetrate into the textile structure and their interface may not be well defined.

Terahertz time-domain spectrometers (THz-TDS) have already proven their potential for non-destructive and contact-free quality control applications, the best-known are layer thickness measurements of polymers and paint layers for example in the automobile industry.

Textiles have been a subject in previous terahertz studies, for example testing their transmission for remote detection of hidden dangerous substances or identifying fabric materials to combat textile counterfeiting.

We present fast terahertz thickness measurements of acrylate coatings on polyester knit fabrics for inline quality control. First, the individual materials are characterized spectroscopically to determine their optical properties in the terahertz frequency range. Based on these findings, we demonstrate the layer thickness analysis of the coatings on knit fabric using terahertz reflection measurements. In the project TeraMeTex (funded by BMWK), we employ a THz-TDS system based on electronically controlled optical sampling (ECOPS), which achieves very high measurement speeds (1600 traces / sec). Combined with a customized, rugged measurement head the setup is ideally suited for inline thickness gauging. The extracted layer thickness results are verified with standard quality control techniques and raster electron microscopy images. THz-TDS systems have reached a promising technology readiness level in recent years. The combination of fast measurement systems with suitable data analysis algorithms now enables online measurements even for such complex materials as coated textiles.

Bahareh Abtahi[1,2], Hans Winger[1,2], Philippa Ruth Christine Böhnke[1,2], Andreas Nocke[1,2], Chokri Cherif[1,2]
[1]Institute of Textile Machinery and High Performance Material Technology (ITM), Technische Universität Dresden (TUD), Dresden (Germany)
[2]Centre for Tactile Internet with Human-in-the-Loop (CeTI), Technische Universität Dresden (TUD), Dresden (Germany)

P87: CeTI - Developments on the human-machine interaction of the future

The central vision of the CeTI cluster is to enable humans to interact in quasi-real time with cyber-physical systems (CPS) in the real or virtual world via intelligent communication networks. On this basis, a democratisation of skills and opportunities, in terms of access to resources, is to be achieved. This should be reached by no longer requiring physical access to infrastructure or by offering control of technical systems and processes so intuitive that specific education for their use will no longer be necessary. CeTI thereby addresses all important areas of people‘s lives - health, leisure, work, learning, etc…

Textiles with integrated electronic components such as sensors or feedback systems are predestined for the realisation of intuitively usable interfaces for communication between people and technical systems.

Depending on the mobility of the body parts to be tracked, the type of movement to be digitised and the resulting resolution required, different technological solutions are necessary.

The poster shows a selection of technologies for tracking and digitalisation of human movements that have been developed/are under development in the CeTI context in interdisciplinary cooperation with colleagues from a wide range of disciplines such as computer science, electrical engineering or psychology.

One focus of current research activities is on the Smart Kinesiotape. In addition to the passive feedback on the user‘s movements, which results from the structure of the tapes, they are equipped with sensors for strain measurement, which enable movement and posture tracking. Integrated active feedback systems are the next development steps.

Achyuth Ram Annadata, Mathis, Bruns, Thomas Gereke, Eric Häntzsche, Andreas Nocke, Iris Kruppke, Chokri Cherif
Institute of Textile Machinery and High Performance Material Technology, TU Dresden, Germany

P88: Hybrid Textile Approach for Interactive Fiber Rubber Composites

In the era of advanced materials, shape memory alloys (SMA) are being widely researched for various applications. Their unique characteristics are exploited in the medical and aviation industries to explore unconventional solutions for existing problems. One such application is the realisation of actuating mechanisms using one of their characteristics, the shape memory effect. Some research has been conducted all over the world on developing Interactive Fibre Rubber Composites (IFRC) based on the shape memory effect. So far, most of the work has focused on two-dimensional bending deformations. This work therefore focuses on developing IFRC with a hybrid textile approach to achieve three-dimensional complex deformations. In this approach, SMA wires are integrated onto uniaxial and multiaxial fiber reinforcements to obtain both torsional-bending deformations. Based on the determined evaluations, a comparative study of the deformations caused by hybrid textiles is performed with respect to a simulation model developed in ANSYS. The derived conclusions are expected to be helpful in obtaining and evaluating 3D spatial movements in IFRC structures with multiple joints.

Keywords: Shape memory alloys (SMA), Hybrid textiles, Interactive fiber rubber composites (IFRC)

Lukas Benecke, Dilbar Aibibu, Chokri Cherif
Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden (Germany)

P89: Liquid Crystal Elastomer Fibers for Biomedical Applications

Electromotric-driven motion in prostheses yields several drawbacks for patients like unnatural noise and movements, as well as lmited degrees of freedom due to relativly high weight of the motors. Liquid Crystal Elastomers (LCE) are a new class of materials that can achieve contraction upon thermal, optical, or chemical stimuly and are therefore promising canditates for replacing electromotors as actuators in biomedical applications. Therefore, it is essential to achieve and fixate a high degree of orientation in the rod-shaped liquid crystals in the desired contraction direction. Upon a defined stimulus, the system aims for maximizing its entropy and loses its orientation. This shifting/rotating of the liquid crystals is transformed on the elestomeric backbone and results in a macroscopic contraction of the LCE.

In this project, we focus in generating a noval spinning technique for producing LCE fibers that can be used as artificial muscle fibers. Through material design, especially the choice of crosslinking reagents and electrothermally conductive additives, we aim to tune the activation temperature to values just above body temperature to ensure a save and energy efficient contraction. Furthermore, mechanical and textile physical characterization is performed on the fibers to show their potential as load-bearing and lifting actuators. Finally, results are compared to shape memory polymers to better classify the results in the context of shape changing polymers.

Quentin Bollengier, David Rabe, Eric Häntzsche, Chokri Cherif
Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden (Germany)

P90: 3D-knitted active joints as integral composite components with structurally integrated actuators

In the course of promoting sustainability through the use of lightweight structures, there is currently a high demand for functionalised fibre-reinforced plastics (FRPs). In particular, adaptive FRPs with both structurally integrated solid-state joints and actuators provide a high innovation potential. Conventional movement mechanisms are usually based on external kinematics with high masses and consequently high energy consumption. By using component-integrated actuator networks, the mass disadvantage of conventional drives can be compensated. For the integration of these in mass-optimised FRP structures, the necessary elements (actuators and voltage supply lines) must already be integrated into the near net shape preform. The aim of this research is the development of adaptive FRPs for the mass-reducing substitution of conventional actuators. These structures can be used, for example, in robotics as a movable robot arm and operated in a more energy-efficient manner. For this purpose, functionalised near net shape reinforcement structures with integrated actuators based on shape memory alloy (SMA) wires were developed and manufactured using flat knitting technology. Special attention was paid to the bionically inspired implementation of flexure hinges in cylindrical component structures (similar to insect legs) with a local stiffness gradient, which is realised by the binary construction of the knitted structure and locally varying matrices. The suitability of the flat knitting technology for the integral production of functionalised reinforcement structures with integrated in-situ actuator networks and solid-state joints for the realisation of adaptive FRP composites was demonstrated on first demonstrators.

Mir Mohammad Badrul Hasan, Anwar Abdkader, Chokri Cherif
Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden (Germany)

P91: Yarns from high performance & metal fibers

Current trends in the areas of material efficiency, electromobility and CO2 reduction on the one hand, as well as increased safety and performance requirements on the other, call for novel material concepts with defined properties and the associated manufacturing technologies. This can be achieved in particular through a targeted combination of conventional fiber reinforced composites (FRC), which have a high degree of stiffness and strength, with metallic materials, which are characterized by their pronounced ductility and the associated higher energy absorption capacity. Current solutions to achieve this are limited on the one hand to the hybridization of different mono-material yarns on the meso level and on the other hand to FRC- metal laminates (FML) built up in layers. However, such FRC-metal composites have the following specific disadvantages: insufficient mixing of the components, very high manufacturing costs and the resulting interlaminar interfaces between sheet metal and matrix. Therefore, the aim of this work is the establishment of basic knowledge and application-related technological fundamentals for the development and production of multi-material yarn constructions made of metal and high-performance fibers mixed at the micro level for use in fiber-metal hybrid composites. The project includes the development, trial and use of a flexible, modularly designed test set-up that enables uniform and gentle intermixing of the various fiber components in different lengths (continuous and staple fibers) at the micro level and in defined proportions for the manufacturing of multi-material yarn constructions.

Karl Kopelmann, Johannes Mersch, Mathis Bruns, Andreas Nocke, Chokri Cherif
Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden (Germany)

P92: Non-destructive process and quality control along the textile process chain

Textile-based high performance materials like fibre-reinforced Plastics (FRP) offer great opportunities in design, weight and mechanical properties. These properties can be tailored to the intended application, so that their mechanical performance can exceed that of components made from conventional materials by far.

A great drawback of FRP are their complex and cost intensive manufacturing, where many defects can occur on different process steps. These defects increase the production waste, the cost and can also decrease the reliability of the entire component. For example, inhomogeneous yarn tension or elongation of the reinforcing yarns during their textile processing can lead to an insuffisient fiber orientation in the composite. This in turn can lead to a loss of the composite‘s stability. There are two ways to target these challenges. First, non destructive quality control can be performed during the production of the semi-finished products. Second, the finished FRP can be monitorded with non-destructive techniques to ensure their integrity.

This poster addresses both possibilities in order to increase the efficiency of FRP manufacture: Using the example of an in-line analysis of the yarn tensions and elongations during the processing of warp knitting machines, options can be derived for improving the manufacturing process of textile semi-finished products and minimizing the defect rate. Additionally, eddy current testing can be used to non-destructively evaluate carbon fiber reinforced composites as well as the uninfiltrated reinforcement multi-layered textile. By varying coil and excitation frequency of the eddy current probes a tomography-like method can be developed.

Dominik Münks, Yordan Kyosev
Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden (Germany)

P93: Novel Stab Protective Clothing, Bio-Inspired, Customised

Employees in the public sector are exposed to an increasing number of assaults and threats. The risk of being injured by a stabbing weapon is significantly higher than by a firearm. The stab vests currently available on the market have an enormous weight due to the integrated protective plates made of aluminum, stainless steel, ceramic layers or similar, which severely limits both ergonomic and thermophysiological wearing comfort. This reduces wearer acceptance, which is an essential basic requirement for ensuring physical integrity and safety for people in the field.

The research objective is to develop stab protective clothing in which functionality (high protective effect) and pleasant wearing comfort (low mass, high flexibility to adapt to the body shape) do not contradict each other. The focus is on bio-inspired interlocking structures, which are additively manufactured using high-performance fiber materials (aramid or continuous glass fiber) or applied directly to elastic textile materials. Due to the intended segmentation and reduction of weight, stab protection textiles for the entire upper body can be produced. Digital development and manufacturing chains are being worked out for this purpose. Furthermore, the innovation potential of the project is to establish additive manufacturing as a new joining technology for the production of textile end products, focusing on the creation of a sufficiently stable bond between textile base material and additively applied plastic/reinforcement material.

Within the scope of the proposed project, findings from bionics will be used to create application-oriented basic knowledge for the development of new textile products and processes (stab-protection vests for armed forces and law enforcement agencies, personal protective equipment (PPE), medical aids, sports equipment), resulting in direct benefits for SMEs in the protective clothing industry as well as in the sports clothing and equipment and medical aids sectors.

Dominik Nuss, Philipp Schegner, Cornelia Sennewald, Chokri Cherif
Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden (Germany)

P94: Advanced Complexe Woven Fabris

The provision of efficiently manufactured near-net-shape fabrics isrequired for numerous applications within many industrial sectors. The ITM at TU Dresden is therefore researching technologies for the production of near-net-shape fabrics in several projects. These enable the production of semi-finished fabric products with reduced waste, load-adapted mechanical properties and geometric contours that meet the requirements. Digital process chains are being developed for the development, design and production of fabric structures for rapid, cost-effective product development in industry.

A current research focus is characterised by the direct weaving of the target geometry with a warp thread course that is true to the final contour. This is achieved by using a specially developed reed with adjustable width. This allows fabrics to be produced on wide weaving machines with adapted warp thread densities and thus fabric widths required according to the target application. Another development is the production of near-net-shape fabrics with adapted widths. For this purpose, a special variable warp thread system was developed, which

enables a temporary weaving of warp threads in the weaving process. Furthermore, the solutions offer fabrics with an adapted fabric width and thickness.

Paul Penzel[1], Lars Hahn[1], Chokri Cherif[1], Marina Stümpel[2], Harald Michler[2], Manfred Curbach[2]
[1]Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden
[2]Institute of Concrete Structures, TU Dresden, Dresden (Germany)

P95: Textile lattice girder for precast concrete

In the construction industry, filigree prefabricated concrete elements are an established and effective solution for ceiling panels and walls, due to rapid construction progress and simple formwork as well as a wide range of applications. However, due to their massive structure and the susceptibility to corrosion of the reinforcing steel, conventional elements made of reinforced concrete reach their limits. With the triumph of textile-reinforced concrete (TRC), which is gradually replacing steel reinforced concrete construction with a new, light, intelligent and flexible way of designing and building, textile reinforcement structures show a great potential for a future application in filigree precast concrete elements. Herefor a new generiation of precast concrete elements is developed at the TU Dresden. The supporting element of the prefabricated parts are corrosion-resistant textile lattice girders, whose structure is based on overlapping of diagonally offset carbon rovings. The development of an efficient textile manufacturing technology, based on multiple warp yarn offset systems for structure formation and 3D-forming of textile reinforcement structures, takes place at the Institute of Textile Machinery and High Performance Material Technology. The Institute of Concrete Structures (IMB) develops an numerically supported reinforcement structure in addition to innovative formwork principles and new design options for the integration of cavities. The aim of the research project is to transfer the textile reinforced concrete technology to the enormous market segment of filigree prefabricated parts in order to equip such elements for the resource-saving construction of the future.

Konrad Zierold, Lars Hahn, Chokri Cherif
Institute of Textile Machinery and High Performance Material Technology (ITM), TU Dresden

P96: Effectively form-fitting multiaxial non-crimped fabrics (NCF)

Waste of expensive high-performance fibers in the fabrication of 2D roll goods causes almost 30 % of the manufacturing costs in the production of Fiber-reinforced plastics (FRP) components with complex outer contours. If it is possible to develop final-contour NCF in which the high performance filaments are only incorporated in the areas where they are needed, the cost of manufacturing FRP components could be significantly reduced.

To this end, a retrofittable additional device for multiaxial warp knitting machines is to be developed with which 0° yarns from the ply build-up process can be cut in sections, temporarily stored and, if required by the contour, fed in again and fixed in the NCF. To this end, a test rig is being developed to examine and evaluate technologies for the above functions outside the multiaxial warp knitting machine. The most important evaluation criterion is the dimensional accuracy of the layed reinforcement yarns in 0°-direction.

In combination with developed project results from research work on the reduction of waste in the weft direction (90°-direction) through the inline production of an alternating weft yarn (consisting of reinforcing and holding yarn components), it would be possible for the first time to produce completely end-contoured fabrics.

Textile manufacturers in particular will benefit from this project. They will then be able to cost-efficiently produce innovative textile semi-finished products for FRP components with component-specific basis weights without having to accept waste and oversizing and will be able to place high-performance NCF that meet requirements on this growing market.

[1]Katarzyna Kobiela-Mendrek, [1]Monika Rom, [2]Ingvild Svorkmo Espelien, [1]Marcin Baczek, [1]Jan Broda, [3]Maria Kohut
[1]University of Bielsko-Biala, Bielsko-Biala (Poland)
[2]Selbu Spinneri, Klæbu (Norway)
[3]Centre of Regional Produce, Koniakow (Poland)

P97: Sound absorbing properties of tufted fabrics made from the wool of Polish mountain sheep

Sheep wool has belonged in the sustainable materials known to humankind since Neolithic times. Recently, the interest in wool from the industry or the craft sector has significantly decreased. The lower demand applies mainly to coarser and multi-fractional wool from local sheep breeds raised in European countries. As a result, a significant portion of this wool is underrated, underused and treated as a troublesome by-product of sheep husbandry. To find a reasonable solution for the use of wool obtained from the mountain sheep raised in the Polish mountains sound absorbing materials designed for interior applications were produced. A portion of wool with better quality was pre-selected and utilised for manufacturing rug yarns. For the production of the yarns narrow carding and spinning machines operated in a small-scale wool processing mill were applied. The ring-spun and core rug yarns were obtained and used for the production of tufted fabric with cut or loop piles. Using an impedance tube, the sound absorption coefficient of the fabrics was measured and the noise reduction coefficient was calculated. It was revealed that the absorption capacity of tufted fabrics depends mainly on the pile height. Simultaneously, it was shown that materials made from wool obtained from the mountain sheep have a good absorbing capacity, comparable to commercial products usually made from more expensive merino wool. The materials combine the ability of noise reduction with decorative function and a nice touch. They can be used as acoustic screens, panels, or carpets.

Elin Wollin, Amelie Olesen, Nils-Krister Persson
Smart Textiles Technology Lab, Smart Textiles, University of Borås and Polymeric E-Textiles, Swedish School of Textiles, University of Borås

P98: Textile modularity – investigating enabling technologies for repair and reuse

A palette of strategies is needed in order for textiles and textile processes to become sustainable. Recent key concepts like circularity and longevity need to advance from policies, company visions and theoretical constructs to real world technical solutions. For this we have here investigated modularity i.e. the approach to construction of products that makes (standardized) parts (easily) exchangeable. The enabler for modularity is fasteners and fastening solutions, enabling attaching and detaching of textile parts to each other. Reasons for textile modularity are in plentitude: easy repair, refreshness, updating, size adaption, washability, separation in waste phase. Historically, the textile community has developed a wealth of fastening solutions. We make an inventory of these and potential others, structure them into families and make criteria for their usefulness from a sustainability point of view.

We define criteria such as a) reversible versus permanent usage; b) manual versus automatized mounting c) manual versus automatized usage, d) slackness versus tightness of the two parts; and e) if the solution supports monomateriality or not.

It turns out that most fasteners do not add to the criteria of monomateriality, this includes for example magnetic solutions. But it is also the case that there are fastening solutions that do not require extra material beyond the very textile itself. But typically here, slack might be a problem. For many fastening solutions there are indeed automatized mounting machines and processes developed. It also turns out that most of fasteners are designed for manual usage, in turn identifying a need for novel solutions adopted to robotic and large scale handling.

Inés Pita Miguélez[1,2], Anders Persson[1], Pontus Blomberg[1], Nawar Kadi[1]
[1]University of Borås, Borås (Sweden)
[2]Ghent University, Ghent (Belgium)

P99: Study of spinnability impediments for cotton recyled fibres due to morphological alterations during simulated production

It is necessary to understand the technical feasibility of textile recycling for a circular value chain. The effect of production processes on textile fibres is pivotal. While the mechanical recycling of cotton fibres has been studied, e.g. in [1][2][3], the effect of manufacturing on fibre properties is less investigated. The impact of industrial production was analysed, and the different steps were deemed to have repercussions on the feasibility of further textile recycling.

Sabrina Kopf, Dan Åkesson, Mikael Skrifvars
Swedish Centre for Resource Recovery, Faculty of Textiles, Engineering and Business, University of Borås, Borås (Sweden)

P100: Influence of hydroxyapatite particle size and shape on melt-spun PHBV fibers for bone grafts

Bone grafts are the second most transplanted tissue helping patents with damaged or diseased bone tissue[1]. Current methods to replace skeletal defects such as autografts (healthy bone tissue from the patient is relocated to the defect side) and allografts (bone tissue from a donor) have different drawbacks such as a limited tissue supply or the risk of disease transmission[2, 3]. Artificial bone grafts of non-toxic biocompatible and degradable materials for example from hydroxyapatite (HA) and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV) try to overcome these drawbacks. While the bioactivity of HA is undisputed the most promising HA shape (spherical, rod or fiber like) and size is still under debate [4, 5]. This study investigates the effect of HA particle size, shape, and concentration as well as the influence of a silane treatment on PHBV/HA blends for fiber production. FTIR of the treated HA confirmed a successful silanization of the HA particles. Preliminary DSC results indicate a slight decrease of crystallinity for PHBV/HA blends (58.08% untreated HA) whereas the treated HA (56.22%) seems to have a stronger effect on crystallinity reduction compared to 59.66% of the neat PHBV. Decreasing PHBV´s crystallinity is crucial to obtain more ductile fibers, suitable for scaffold production by textile technologies. Further characterizations of the fibers by SEM, TGA, tensile testing and degradation in simulated blood matrix are pending.

Anne-Marie Grundmeier[1], Dirk Höfer[1], Marcus Adam[2], Jochen Strähle[2], Mirela Blaga[3], Zlatina Kazlacheva[4], Zlatin Zlatev[4]
[1]University of Education Freiburg (Germany)
[2]Reutlingen University, Reutlingen (Germany)
[3]George Asachi Technical University, Iaşi (Romania)
[4]Trakia University, Stara Zagora (Bulgaria)

P101: Education for Sustainable Development – a Guiding Principle in Textile Curricula

A strong demand for sustainable products and processes in the textile and fashion industry and its global markets imposes a continuous implementation of the guiding principle Education for Sustainable Development (ESD) in textile education and industry. To achieve this goal, the European project "Sustainable Fashion Curriculum at Textile Universities in Europe - Development, Implementation and Evaluation of a Teaching Module for Educators" (Fashion DIET) develops digital teaching and learning arrangements within a partnership of a university of education and unversities with textile departments (project duration: 09/2020 - 08/ 2023). In an initial step, the project elaborated a further education module on ESD in the context of fashion and textiles, based on a survey of over 120 university lecturers in the three partner countries Bulgaria, Germany and Romania. The three-part module comprises 42 lectures with didactic-methodical concepts, sustainable fashion design and corresponding production technologies as well as sustainable orientation of the fashion market. It aims to enrich established textile-related curricula at universities and vocational schools. For participatory development the ESD module is tested and evaluated by lecturers and educators from the partner countries in three Learning, Teaching and Training events. The project content is provided as Open Educational Resources via Glocal Campus, an open access e-learning platform, that enables virtual collaboration between universities. In addition, the Fashion and Textile Resource Center, a comprehensive database to collect up-to-date information on fashion and textile related topics is developed. Fashion DIET thus strengthens the quality and relevance of sustainability-oriented textile engineering and management education.

Nasr Litim[1], Ayda Baffoun[2], Dorra Ben Kahla[3], Mohamed Hamdaoui, Saber Ben Abdessalem
[1]Textile Materials and Processes Research Unit (MPTex) - University of Monastir 5000, Tunisia
[2]Laboratory of Textile Engineering (LGTex) - University of Monastir, Monastir 5000, Tunisia

P102: Benefit Study of Ecological Compounds GALACID XT 88 Based on Lactic Acid and GALASOLV NF 62 Based on Ethyl Lactate and Their Impact on the Surface and Mechanical Properties of Cotton Fabrics

Two compounds „GALACID XT 88“ based on lactic acid and „GALASOLV NF 62“ based on ethyl lactate as being a green solvent, which are biodegradable and renewable compounds. In this study ,we attempted these compounds to use in finishing treatment, especially applied on cotton denim fabric in order to get 3D effects like fashion require. The mechanical, morphological, microscopic characterizations as well as the evaluations obtained were elaborated on the treated fabrics in two steps; before wash BW and after wash AW. In two steps of finishing , Both compounds give acceptable Dry crease recovery angle, but it seems that compound based on ethyl lactate is better in DCRA quality compared to compound based on lactic acid after wash. We finish that the ecological compounds gives a satisfy quality of 3 D effects. Consequently, these compounds preserve the mechanicals properties during two steps (GALACID XT 88 causes loss of 25 % max. and GALASOLV NF 62 cause loss of 8 % max.). These results are proved using Kawabata evaluation system and Surface morphology by SEM. Indeed these compounds improve the quality of treated fabric.

Martinia Glogar, Tanja Pusic , Veronika Lovreskov , Tea Kaurin
University of Zagreb Faculty of Textile Technology

P103: Some aspect of dyes application on Inherently flame resistant fabrics

Research into the possibility of applying dyes in the processes of dyeing and printing on inherently fire resistant fabrics is presented The overall research is part of the project of development of Inherently Flame Retardant Fabric for Dual Use, funded by the European Union from the European Regional Development Fund, and in which the University of Zagreb Faculty of Textile Technology is a partner to Croatian producer of protective and functional textile, Cateks d d In order to achieve optimal levels of flame resistance, various inherently flame resistant fibers in different proportions have been combined, and new fabrics were designed and tested Considering the relatively high proportion of aramid fibers in such mixtures, the application of dyes and the achievement of coloured effects by conventional dyeing and printing procedures is extremely complex During the research, the possibility of using reactive in printing process as well as vat dyes in dyeing process, was tested.

AACHEN DRESDEN DENKENDORF
INTERNATIONAL **TEXTILE** CONFERENCE

Thank you for participating in the

AACHEN-DRESDEN-DENKENDORF INTERNATIONAL TEXTILE CONFERENCE 2022!

We‘re looking very much forward to seeing you again next year in Dresden!

Wir bedanken uns für Ihre Teilnahme an der

AACHEN-DRESDEN-DENKENDORF INTERNATIONAL TEXTILE CONFERENCE 2022

und freuen uns schon darauf, Sie nächstes Jahr in Dresden begrüßen zu dürfen!