SMART TEXTILES SALON

Vol. 6

Prototypes on Stage, 18 October 2017
in Het Pand, Ghent, Belgium

PROCEEDINGS

Welcome!

Els
Van der Burght

Carla
Hertleer

Lieva
Van Langenhove

Today smart textiles have become a global but still exciting and largely uncovered research field, and some products have reached market breakthrough. This is what the EU project SYSTEX was aiming at. The Smart Textiles Salon (STS) is now in its 6th edition.

This year STS Vol. 6 takes place as part of the ITMC conference, that focuses on Intelligent Textiles and Mass Customisation. This offers presenters the opportunity to first explain the scientific details of their prototype during one of the ITMC smart textile sessions and then to demonstrate it during the STS. Just like the previous edition, the STS is co-organised with SMARTPRO, a Belgian project on industrial manufacturing of smart textile products.

Over 25 researchers, designers, students and companies will show their prototypes in the historical conference centre of Ghent University, Het Pand.

We welcome you at the Smart Textiles Salon and we hope it brings inspiration for further innovation and successful developments.

We appreciate your active participation and hope you enjoy this event!

Lieva

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The SMARTpro project

Smart Textiles and wearable intelligence: from intelligent prototypes to industrial and practical products

By stimulating the collaboration across the ICT, electronic and textile sectors by means of the SMARTpro project we aimed at supporting companies in application-specific product development and production of smart textiles and wearable systems.

This intense cooperation for four years resulted in a number of demonstrators integrating movement sensors in clothing using the integration of conductive yarns and printing of conductive inks.

When combining these smart textiles demonstrators with other data sources we were able to demonstrate the underexploited potential for more advanced and personalized activity monitoring.

FLANDERS INNOVATION & ENTREPRENEURSHIP | Flanders State of the Art

SMART pro

Mark Croes

Graduate in Biochemical Engineering Technology at the Engineering Technology College Groep T in Leuven.

Mark joined Centexbel in 2002 as a Technological Advisor and Innovation Consultant for the Health and Safety Laboratory and was coordinator of the four-year running SMARTpro project supported by Flanders Innovation & Entrepreneurship.

The project with focus on the industrial development of smart textiles and wearable intelligence, brought together major research organisations (Centexbel, Sirris, IMEC, HoGent, UGent, KULeuven and Cretecs-Vives) and a user group of over 30 companies.

SMARTpro case – Activity monitoring with the help of smart textiles

Olivier Vermeersch

A graduate of the ENSISA (Engineering School in Mulhouse, France) and the University of Haute Alsace in France in Textile Materials & Processes Engineering, Dr. Vermeersch has been involved in the technical textile industry since 1990 within the CTT Group, the largest R&D laboratory in Canada in the areas of technical textiles, geosynthetics and flexible materials. He holds the position of Vice-President R&D and is also Chairholder of the NEXTEX Industrial Chair of St-Hyacinthe College, a Canadian NSERC Level 2 Chair that focuses on 3D textiles & preforms for composites as well as smart textiles. He is the author of several patents, which are commercially exploited by several of his industrial partners. Involved in organising several EXPO HIGHTEX editions for a decade, co-editor-in-chief of "The Textile Journal" until 2016, author of numerous technical and scientific publications, he is also co-author of a book that will be released soon by Elsevier on the "Advanced characterisation and testing of textiles". In 2014, he was awarded the prestigious Excellence Award from the Fonds de recherche Nature et Technologies du Québec.

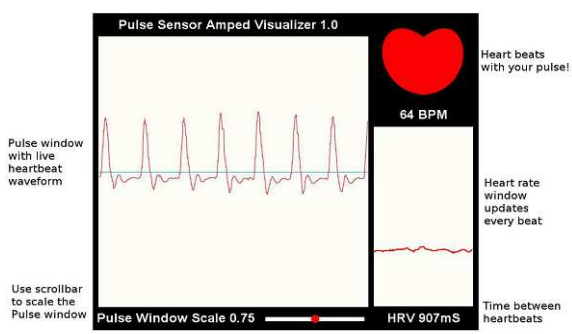
Smart Textiles: from lab prototyping to production and commercialisation

Prototypes on Stage

Smart Wheel Chair

Houssem GASSARA, Ali MOUKADEM, Dominique ADOLPHE, Alain DIETERLEN, Laurence SCHACHER

houssem-eddine.gassara@uha.fr



This project has been developed in the frame of a project call supported by the Foundation Alfred and Valentine Wallach and the Partnership Foundation of Haute-Alsace. It is dedicated to the development of special devices for elderly and handicapped persons in order to monitor their well-being and to facilitate their stay at home. To achieve this goal, a mixed team composed of Textile (LPMT) and Signal Treatment (MIPS) Researchers work together for inserting and connecting sensors into the wheelchair in a non-intrusive manner and for treating the obtained data in order to extract the well-being of the user.

The main achievement has been to determine the location of the sensors, regarding the specificities of the final users and to connect them to the transmission unit. After a localisation study, 24 sensors (pressure, temperature and humidity) were inserted into the wheel-chair, and the connection to the power supply and the transmission unit were carried out thanks to the embroidery of metallic (stainless steel) threads. An embroidered electric circuit was developed. Different signal treatments were achieved and software dedicated to the user interface was implemented.

Currently, the first prototype was developed and is under intensive trials in the Medical Recovery Center in Mulhouse (CRM), France.

Houssem Eddine Gassara, Dr, Post- Doctorate – LPMT- University of Haute-Alsace
Ali Moukadem, Dr, Associated Professor, MIPS – IUT Mulhouse, University of Haute-Alsace
Alain Dieterlen, Prof. Dr., Professor, MIPS – IUT Mulhouse, University of Haute-Alsace
Laurence Schacher, Prof. Dr., Professor, LPMT, ENSISA, University of Haute-Alsace
Corresponding author: Dominique C. Adolphe, Prof. Dr., Professor, LPMT, ENSISA, University of Haute-Alsace, 11, rue Alfred Werner – 68093 Mulhouse, dominique.adolphe@uha.fr

INGA Wellbeing Smart Patient Wear

Frederick BOSSUYT and INGA Wellbeing Staff members

frederick.bossuyt@imec.be

This prototype was made in the frame of the SmartPro project.
On a cotton fabric, four parallel conductive yarns are stitched acting as a bus system between a sensor module and a Bluetooth node. The conductive yarns - provided by Bekaert - allow powering and communication between the electronic modules.
The demonstrator shows the feasibility of using conductive yarns to connect different electronic modules electrically with each other. In this way, the textile properties of the cotton fabric can be maximally maintained. The prototype can be used for activity monitoring.
In a straightforward way, other sensors can be added to the fabric.

Frederick Bossuyt works at the Centre for Microsystems Technologies, which is part of Ghent University and imec. He is involved in research on stretchable electronics and textile integration technologies.

Smart Narrow Fabrics

Frederick BOSSUYT, Annick DEPRE

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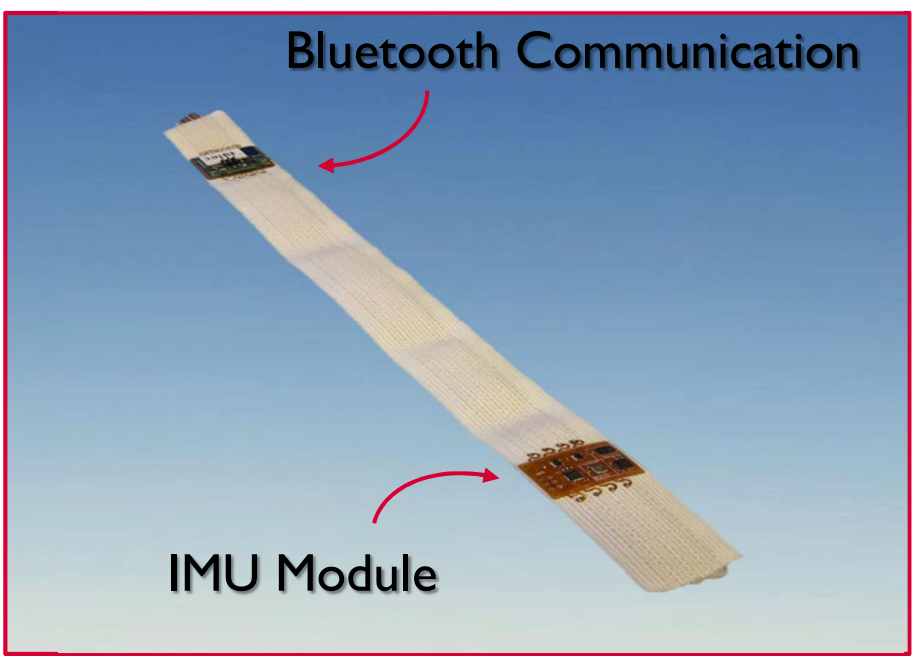

Elasta nv has a long experience in weaving, braiding and knitting narrow fabrics, ribbons and laces, elastic as well as non-elastic. Elasta also develops new and innovative products in close cooperation with its customers and with research institutes.

This prototype was made in the frame of the SmartPro project. The narrow fabric including conductive yarns from Bekaert is equipped with a sensor node and a Bluetooth node. Communication between the sensor node and the Bluetooth node happens using the conductive yarns.

The demonstrator shows the feasibility of using conductive yarns to connect different electronic modules electrically with each other. In this way, the stretchable properties of the narrow fabric can be maximally maintained. The prototype can be used for activity monitoring. In a straightforward way, other sensors can be added to the fabric.

Frederick Bossuyt works at the Centre for Microsystems Technologies, which is part of Ghent University and imec. He is involved in research on stretchable electronics and textile integration technologies.

Annick Depré is owner of Elasta nv located in Textielstraat 15, 8790 Waregem, Belgium.

Circuit – Jacket with heart rate display

Daniel FRASQUETTE, Bárbara BEDENDO, André CATARINO, Helder CARVALHO, Fernando FERREIRA

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The "Circuit" jacket is a flashing garment for running at night. Besides signalling the runner in traffic, it displays the heart rate zone the user is currently in and it flashes the lights in red every time the heart beats. Good for night running or for sports events at night. For athletes that like to monitor themselves and display the effort of their workout to others. The jacket comes bundled with a smartphone app that records heart rate data and allows configuration of the heart rate zones and setting the jacket to other LED display modes.

Developed in cooperation with Damel Technical Textiles Manufacturer (www.damel.pt).

Helder Manuel Teixeira Carvalho is currently Assistant Professor at the Department of Textile Engineering at the University of Minho and researcher of the Centre for Textile Science and Technology. He graduated in Electrical and Computer Engineering at the Faculty of Engineering of Porto University and holds an MSc and a PhD Degree in Textile Engineering from the University of Minho.
His research work has been centred on research and development at various interfaces between Textile and Electrotechnical Engineering, namely sensors, process instrumentation, automation and control, and especially on e-textiles, focusing on the development of textile-embedded or integrated devices for sensing and actuation. He is particularly interested in applications of continuous monitoring in sports, health and professional environments, among others.

LIGHTness – A ballet dress that displays lightness and strength of performers in this art

Virgínia ViIANA, Rachel BOLDT, André CATARINO, Helder CARVALHO, Fernando FERREIRA

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Universidade do Minho

CENTRO DE CIÊNCIA E TECNOLOGIA TÊXTIL

COMPETE PROGRAMA OPERACIONAL FACTORES DE COMPETITIVIDADE

QUADRO DE REFERÊNCIA ESTRATÉGICO NACIONAL PORTUGAL 2007.2013

UNIÃO EUROPEIA Fundo Europeu de Desenvolvimento Regional

FCT Fundação para a Ciência e a Tecnologia MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA

LIGHTness is a project in which the authors want to materialise the dichotomy between lightness and strength in ballet performance. The dress uses an accelerometer and two force sensors placed on the pointe shoe tips to sense the type of movement and technique and displays effects correspondingly. The sensor signals on the shows are transmitted wirelessly. Besides serving as an amplifier for the choreography, the dress also shows and stresses the moments in which the performer executes the difficult "en pointe pose". This makes the viewer aware of the strength and endurance ballet dancers employ in their art.

Developed in cooperation with Ballet Dress Manufacturer "Ballet Rosa" (www.ballet-rosa).

Helder Manuel Teixeira Carvalho is currently Assistant Professor at the Department of Textile Engineering at the University of Minho and researcher of the Centre for Textile Science and Technology. He graduated in Electrical and Computer Engineering at the Faculty of Engineering of Porto University and holds an MSc and a PhD Degree in Textile Engineering from the University of Minho.
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Photovoltaic Textile for Smart Applications

Hajar JAOUANI, Mohamed DALAL, Denoun SAIFAOUI, Habiba ENNAMIRI

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The need for comfort in our daily life leads to a powerful addiction to electric energy consumer devices even in our leisure time, because of their flexibility, fineness and lightness. Textiles can be a very good support to produce electrical energy by integrating organic solar cells directly into the textile. Different applications benefit from this technology: flexible chargers, tents, blinds.

This prototype mainly focuses on exchange of knowledge related to smart textiles in general and electro-conductive textiles in particular, to explore and develop photovoltaic cells to get flexible photovoltaic textiles based on new fibres allowing to take benefit from the solar radiation so as to turn it into electrical energy. For our prototype, we have integrated flexible LEDs in conductive wearable textiles in order to switch LEDs or charge batteries by organic photovoltaic cells.

Hajar Jaouani, PhD student in the REMTEX laboratory at the Higher School of Textile and Clothing Industry (ESITH). REMTEX works on smart textiles on different applications. Our prototype is a part of innovative projects in our laboratory.

Prof. Dr Mohamed Dalal is a very active member of the REMTEX research laboratory at the Higher School of Textile and Clothing Industry (ESITH), whose main objective is to develop research that is both creative and applied. His choice of research on advanced materials positions it in a collaborative interface with other industries that seek to use textile fibres as reinforcement and to develop new products. He is currently contributing and coordinating several R&D projects related to the use of flexible LEDs in wearable textiles in the domains of smart and protective clothing and also of fibre reinforced concrete in the domain of civil engineering.

CAREWARE – Smart textile for monitoring recovery after hospitalisation

Brecht DEMEDTS

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A prototype is being developed that allows for the monitoring of movement of a textile. The movement sensor is integrated into a shirt that can be worn by patients in the hospital. Recovery of the patient is followed by the increase of the intensity of movement detected from recovering patients. The developed algorithms allow for an improved guidance of the patient with a decreased effort by the medical staff. The garment detects the movement through a capacitive sensor, specially designed for low power usage. The smart textile is the result of a cooperation between the micro-compound producer NXP, the confectioning company Alsico, the telecommunication specialist Televic, the industrial technology centre Sirris and the textiles knowledge centre Centexbel in the framework of the Eureka-ITEA programme, funded by VLAIO.

Brecht Demedts is working in the Textile Functionalisation & Surface Modification group of Centexbel, which has years of expertise in the field of smart textiles. Centexbel tries to develop prototypes of smart textiles and aims to develop technologies that can be implemented by the industry.

SMARTpro – printed electronics for the integration of sensors in textiles

Brecht DEMEDTS

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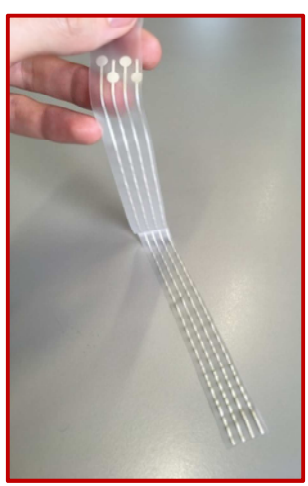

During the SmartPro project, different methods and materials are tested in order to make smart textiles. Part of the project was specifically focusing towards printed electronics for textiles. A demonstrator is made where conductive tracks are used for the signalling between a remote sensor and a battery/Bluetooth module. The technology makes use of different printing, coating and adhesive technologies and the different products were tested in accredited testing. This prototype demonstrates the use of printed electronics in textiles and is developed with the financial support of VLAIO.

Brecht Demedts is working in the Textile Functionalisation & Surface Modification group of Centexbel, which has years of expertise in the field of smart textiles. Centexbel tries to develop prototypes of smart textiles and aims to develop technologies that can be implemented by the industry.

Elastic LED Textile

Annick DEPRÉ

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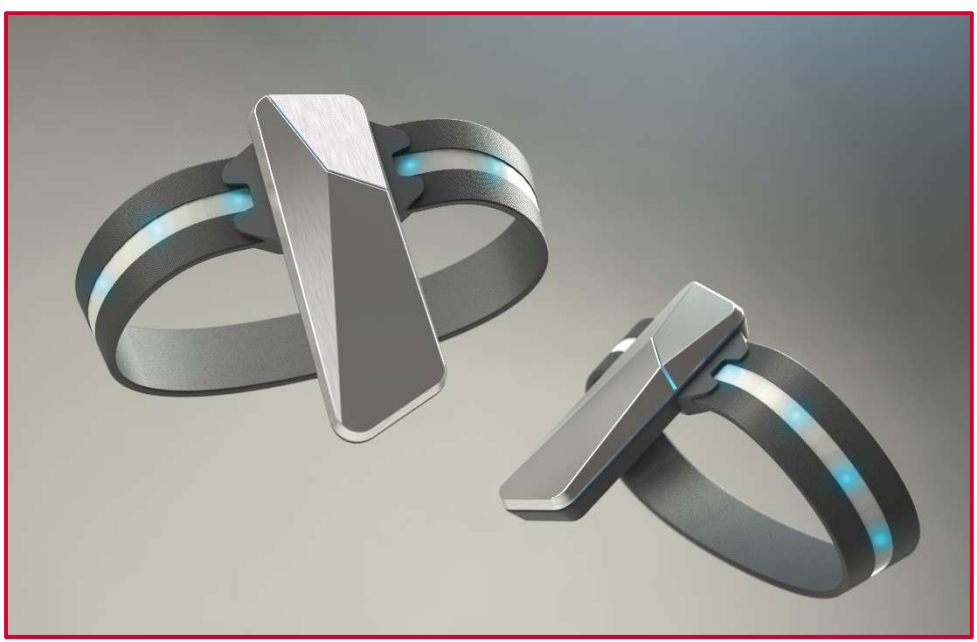

Elasta nv has a long experience in weaving, braiding and knitting narrow fabrics, ribbons and laces, elastic as well as non-elastic. Elasta also develops new and innovative products in close cooperation with its customers and with research institutes.

LED incorporated elastic textile fabric – The elastic fabric retains its elastic properties while emitting light with a light weight and small rechargeable battery and commanding device. The same technology may be adapted to incorporate other sensors.

Annick Depré is the owner of Elasta nv located in Textielstraat 15, 8790 Waregem, Belgium. Elasta manufactures narrow fabrics through weaving, braiding and knitting.

Embedding of electric conductive yarns by 3D printing

Laura ERKENS, Eliza BOTTENBERG, Marijke TIMMERMANS, Jenny HESSE, Maurits MAX and Ger BRINKS

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An electric circuitry was applied on a textile fabric, using electrically conductive yarns and 3D printing of Filaflex filaments.

Electrically conductive stainless-steel yarns were connected to LED's, power and processing, followed by application on a woven cotton fabric. By 3D printing of the Filaflex filament (a TPE thermoplastic elastomer based polyurethane) on the fabric as well as on the conductive yarns, a protective layer for the electrically conductive circuit was produced. For printing the Cartesio 3D Printer was used at Saxion research group Smart Functional Materials, in the Netherlands. The electric circuitry is flexible, bendable and even drape-able, like textile fabrics. It can be integrated in various textile products like garments, interior textiles or technical textile applications. This smart textile product is a first prototype within the vision of the research group to 3D print washable, isolated conductive circuits on textiles in one production step.

Laura Erkens is researcher at the Saxion research group Smart Functional Materials (SFM), in the Netherlands. Laura received her Master's degree in Advanced Textile Engineering. Since 2013, she is working as a researcher at SFM, participating in several research projects related to smart textiles, surface modification and sustainable textiles.

Texenergy: solar energy harvesting and storage in textiles

Laura ERKENS, Eliza BOTTENBERG, Marijke TIMMERMANS, Jenny HESSE, Maurits MAX and Ger BRINKS

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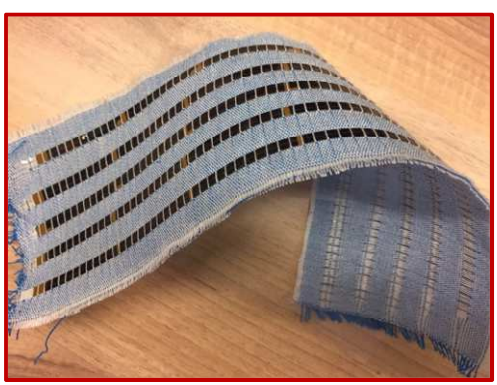

Texenergy is a four-year Dutch research project, focusing on solar energy harvesting and storage in textiles, led by the Saxion research group Smart Functional Materials. Ten companies and two universities collaborate on the development of several textile prototypes, containing the latest (of the shelf) innovative flexible solar cells and batteries. More information about Texenergy can be found at www.texenergie.nl.

Several prototypes have been developed by students and researchers. Firstly, a nurse uniform with integrated solar cells from Cotton/Polyester fabric. The solar cell circuitry with a-Si solar cells is a detachable panel and can be connected to charge devices like smartphones, tablets and peepers.

Secondly, two cycling shirts with integrated flexible solar cells and batteries were developed. One shirt contains a detachable solar cell panel and pulse sensor to measure heartrate. The second shirt with integrated flexible solar cells provides energy to a LED. This,shirt contains an integrated wiring system, made by technical embroidery of conductive copper wire. Both cycling shirts are made of sport fabrics, flexible a-Si solar cells and a Prologium battery.

Finally, flexible CIGS solar cell tapes were integrated in a plain weave fabric, during the weaving process on an Evergreen automatic sampling loom. The woven fabric with flexible solar cells, shows that the integration of flexible solar cells in a textile fabric is possible, while keeping it flexible and bendable at the same time.

Laura Erkens is researcher at the Saxion research group Smart Functional Materials (SFM), in the Netherlands. Laura received her Master's degree in Advanced Textile Engineering. Since 2013, she is working as a researcher at SFM, participating in several research projects related to smart textiles, surface modification and sustainable textiles.

Real time measurement of the resin flow movement inside composite structure during infusion process

Abderrahmane FACI, P. WANG, Cédric COCHRANE and Vladan KONCAR

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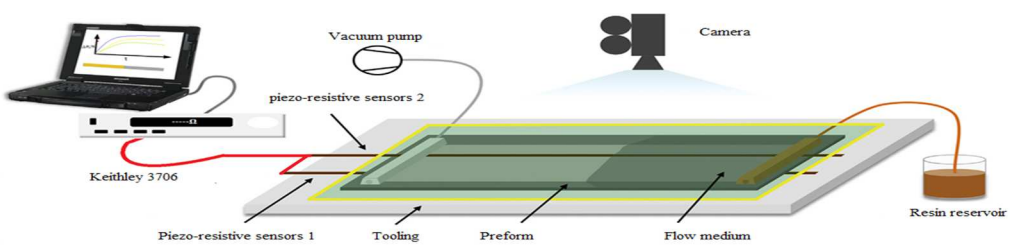

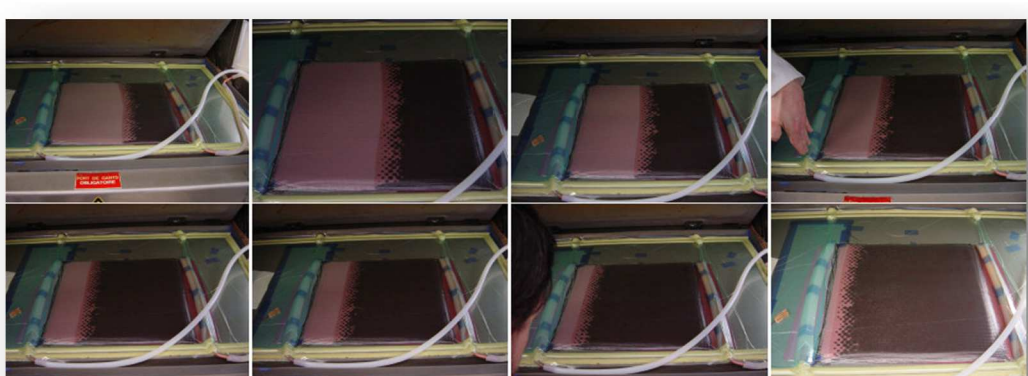

The infusion process is of the utmost importance for the production of high quality composite parts. However, the monitoring and control of this process is not well developed. Therefore, a monitoring system of the resin flow for thermoset composites was developed and realised. It is based on external monitoring via a camera, but also on the in-situ monitoring (inside composite) in real time based on embedded fibrous piezo resistive sensors able to locally detect the resin.

During the infusion process, the Go-Pro camera was used to film the resin flow progress inside the composite. In the same time, nine fibrous sensors embedded into the composite structure were used to measure the same resin flow in situ in real time.

A comparative analysis was realised on the data obtained from the resin flow from the outside camera and the resin flow detected with the embedded sensors.

Abderrahmane Faci is an engineer of hydraulic and fluid mechanics and a PhD student at the University of Lille1, ENSAIT in France. After the graduation, he worked as a research and development engineer in the LARYLSS Laboratory in Algeria and IMFT France.
Actually, he is in the second year as a PhD student in the area of Automatic Control, Computer Engineering & Signal Processing. He is interested in the monitoring of resin infusion.

Anti-theft truck tarpaulin

Frederik GOETHALS

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The prototype that is presented is an anti-theft truck tarpaulin. By cutting it, an alarm will go off and the driver will be warned that someone is trying to steal the goods present inside the truck. The tarpaulin is a hybrid PVC coated textile. The sensor threads which are integrated into the textile are stainless steel yarns. These yarns not only provide the cut detecting functionality to the textile, but they also improve the cut resistance of the textile. The PVC coating is waterproof and performed weathering tests show that the coating does not delaminate or deteriorate by UV, humidity or changes in temperature. Also, the sensor functionality is maintained during these tests.

Acknowledgements – This work was supported by the CORNET programme, VLAIO (Patecs project grant No. 140814) and AIF.

Frederik Goethals is a researcher of the Textile Functionalisation & Surface Modification Group at Centexbel, Technologiepark 7, 9052 Zwijnaarde, Belgium.

A Rehabilitation Wearable: Smart Glove for Rheumatoid Arthritis

Gozde GONCU-BERK, Nese TOPCUOGLU

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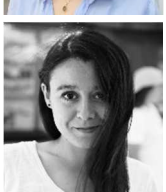
Rheumatoid Arthritis is defined as a chronic, autoimmune disease and systemic inflammatory disorder that primarily affects small joints of the hands.

The submitted prototype is a smart glove for rehabilitation of painful swelling of joint linings, stiffness in morning hours and joint deformity symptoms of the hand. The prototype glove delivers electrical nerve stimulation through skin, namely Transcutaneous Electrical Nerve Stimulation (TENS), by the embroidered e-textile electrodes and transmission lines created through integration of conductive threads on textile surface and their insulation via membrane lamination.

For treatment of swan neck deformity of fingers and ulnar deviation of the hand caused by Rheumatoid Arthritis, compression thermoplastic polyurethane membranes are laminated on the finger joint area of the glove and a support structure for the wrist is integrated in the glove as a splint.



Dr. Gozde Goncu-Berk received her PhD degree in Design with Apparel Studies track from the University of Minnesota, USA. She holds a MA degree in Clothing Design and a Bachelor's degree in Industrial Design from the Istanbul Technical University, Turkey. Currently, Dr. Berk is an Assistant Professor at Istanbul Technical University, College of Textile Technologies and Design and vice department head of the Textile Engineering Department. Her research interests are new product development processes, functional apparel design, wearable products for healthcare applications, sustainability and cross-cultural aspects in apparel design.

Nese Topcuoglu is studying Master of Science in Textile Engineering Program of the Istanbul Technical University and graduated from the Industrial Product Design Department of the same university. She is interested in design.

Combining wearables and environmental sensors for advanced indoor localization and personalized activity monitoring

Nicolás GONEALEZ-DELEITO, Andriy ZUBALIY

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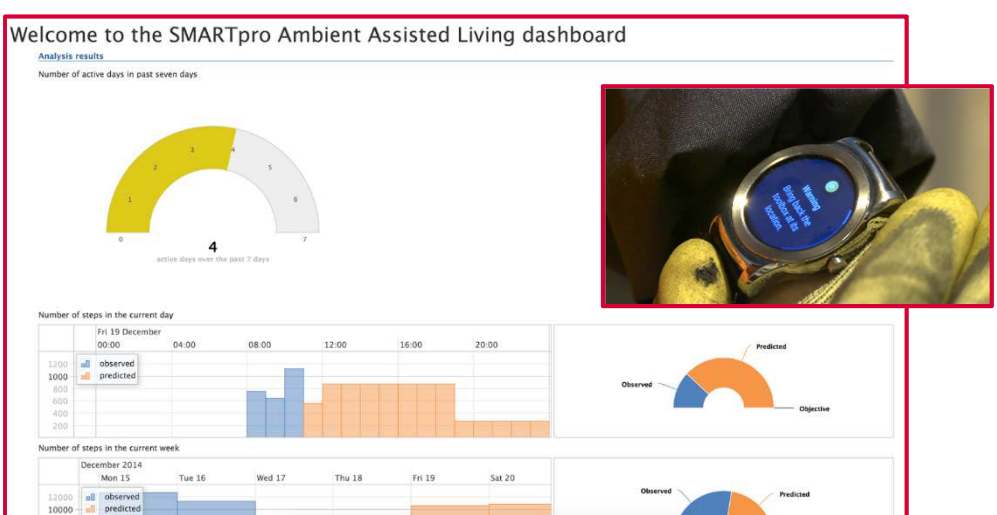
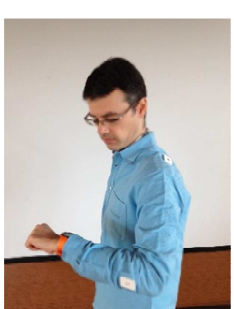


The prototypes to be presented aim to demonstrate concrete applications and opportunities that are enabled (1) by integrating sensors into textiles and wearables and (2) by enhancing these with additional data sources such as sensors embedded in the environment.

Three prototypes will be presented by means of videos, illustrating how the aforementioned objectives can contribute to (1) ensure safety in an industrial environment, (2) promote healthy activity habits in an office environment, and (3) monitor outdoor activities in a user-friendly way for ambient assisted living.

A fourth prototype, illustrating the technology used in the prototype for ensuring safety in an industrial environment, and realized in collaboration with imec and Ho-Gent, will be shown live at the STS.



Nicolás González-Deleito is Project Leader Data Innovation at Sirris. The Data Innovation team helps companies build new or improved products and services based on the data they possess or have access to. This is mainly done through short commercial trajectories, through the setting up and execution of industry-oriented R&D projects, and through building up technology demonstrators. Nicolás currently contributes and/or coordinates several R&D projects related to the use of wearables in the domains of health/homecare and lifestyle, such as CareWare (www.careware-itea.eu) and SMARTpro (www.smart-pro.eu).

Andriy Zubaliy recently joined Data Innovation team at Sirris. He started as a Data Scientist after his graduation as master of science in electronics and ICT engineering technology. He was already involved in the SMARTpro project during his master's thesis. Andriy currently contributes to SMARTpro, CareWare and MANTIS projects.

Textile sensors and related textile reinforced thermo-plastic composites

Ivona JERKOVIC, Ana Marija GRANCARIC and Vladan KONCAR

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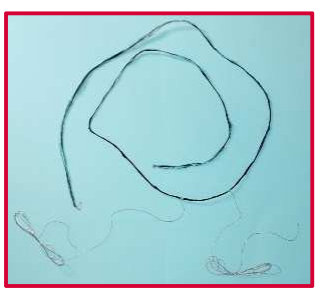

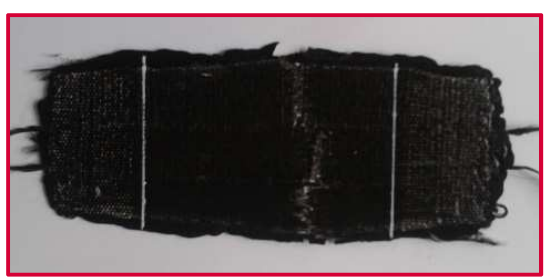

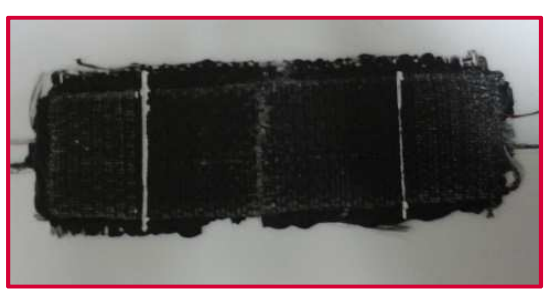

F-glass/polypropylene (GF/PP) and E-glass (GF) yarns produced by the *P-D FibreGlass Group*, Germany, were used for the production of the textile sensors. The sensors were made by a novel roll to roll coating method with two conductive coatings, 8% poly(3,4-ethylenedioxythiophene)-poly(styrenesulfonate) (PEDOT:PSS) in CLEVIOS F ET (Heraeus)/Latex Appretan 96100 (Clariant), between protected coatings, Latex Appretan 96100 (Clariant), applied to the neat yarn. The length of each sample is one meter. Copper twisted wires (Conrad) with a diameter of 0.20 mm, were inserted around a conductive coated yarn before applying a last protective coating with a paintbrush (3 twists) at a distance of 5 cm. Two GF/PP or GF sensors were integrated during weaving of 2D GF/PP fabrics (warp density, 4 ends/cm and weft density, 6 ends/cm), 4-end satin, fabric thickness ~2.660 cm, at the ARM computer controlled hand weaving loom. Three layers of 2D fabrics with the middle layer with integrated sensors were consolidated at the heating press (Dolouets, France) during 5 min under a temperature of 185ºC, and a pressure of 40-50 bar followed by sudden cooling at 100°C in 2-3 minutes. Electrical resistance measurements of sensors were performed after their production, integration in 2D fabrics and consolidation of 2D textile preforms. Textile sensors integrated in 2D fabrics showed resistance to high temperature and pressure and possibility for *in situ* structural health monitoring of textile reinforced thermoplastic composites.

Prof. **Ana Marija Grancaric**, PhD, Ivona Jerkovic, BSc - Department of Textile Chemistry and Ecology, University of Zagreb, Faculty of Textile Technology, Zagreb, Croatia
Prof. Vladan Koncar, PhD, GEMTEX Laboratory, Ecole Nationale Supérieure des Arts et Industries Textiles, Roubaix, France

Light-emitting Sweater with Integrated LED Sequins

Melanie HOERR

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The prototype shows a sample of a 'Wearable' or 'e-Textile' and shows the Z of the ZSK Logo with 14 integrated LED Sequins on a sweater.
Embroidered e-textiles allow the integration of electronics and circuits into your clothing and accessories to create a range of both fashionable and technical functions.
Light-emitting textiles can be used just as a fashionable lighting function or as functional elements as in safety and protective clothes. A further area of application is the automotive interior design. LED Sequins can be used for individual lighting concepts in the interior because the textile integration enables the combination of design and technology. Another advantage is the automated placement and the connection of the LED Sequins which is done by the embroidery machine. The LED Sequins are applied automatically to a textile carrier material by a functional sequin device attached to the embroidery machine. In order to connect the battery reversibly and bring the LED's to light, conductive pads are embroidered and covered by snap fasteners. The conductive paths and sequins are hidden under satin stitches to make the embroidery design more appealing as well as to protect the tracks from external effects.
The hereby shown integration of LED Sequins in a sweater should be seen as a simple example for the possibilities of the integration of electronic parts into textiles by technical embroidery. Instead of simple LED technology, whole microcontroller boards on flexible substrates could be integrated into textiles by using this technology.

Melanie Hoerr earned her diploma in mechanical engineering at RWTH Aachen University and worked as research assistant & group leader at the Textile Institute. Her research topic is technical embroidery & smart textiles. Since June 2016, Melanie has been Manager of Technical Embroidery Applications at ZSK

AiQ Respiration Shirt

Steve HUANG

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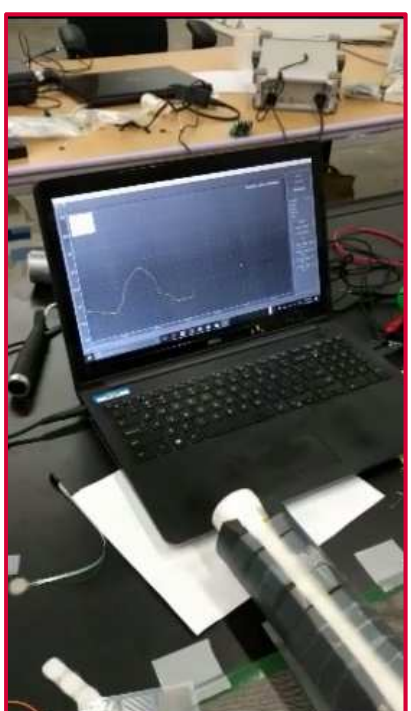

So far most of the wearable respiration measuring systems are approached by stretch sensors. The sensors are either wide tapes, which are difficult to be installed, or thin threads with relatively weak signals. Moreover, the sensor has to be worn across the chest so that the expansion of the chest can be measured. To increase the sensitivity and optimise the mechanical structure, AiQ's idea is to utilize an embedded pressure sensor located on the side of the chest. Instead of stretching force change, there will be a pressure change on the contact between the sensor and the body caused by expansion of the chest. The sensor we choose is a printed ionic type which can be made as a small piece of fabric base or TPU base sensor. With this textile structure, installation of the sensor on the garment becomes much easier than installing a mechanical type and the user may really not feel the sensor is existing, which is also our ultimate goal for a natural wearing user experience.

The co-founder and Executive Director of King's Metal Fiber Technologies, **Steve Huang**, established AiQ Smart Clothing BU in 2009, and is deeply involved into innovative industries. He strives to stay ahead of the industrial trend eager to steer AiQ from an SME towards becoming an international role-model in the smart clothing industry.

E-textile integration for physiological monitoring system

Tzu-Hao HUANG, Xuyuan TAO, Gwo-Tsuen JOU, Ya-Chi KO, Po-Chun HSU, Chien-Lung SHEN, Vladan KONCAR

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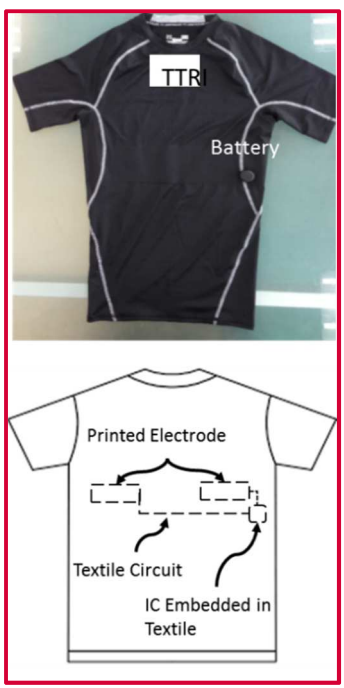

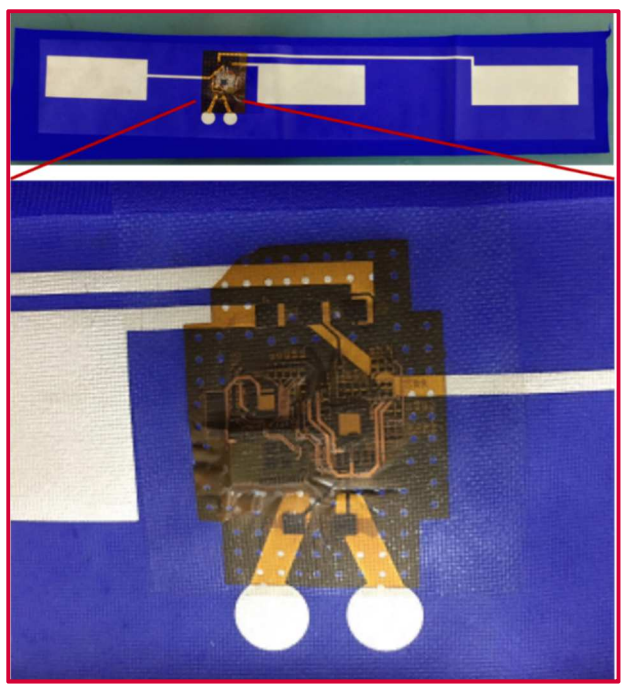

This prototype is made by integrating a printed textile circuit board, FPCB (flexible printed circuit board), and IC Chips into a fabric for physiological monitoring. This fabric can be used to detect physiological signals such as heart rate, ECG, movement, temperature, and respiration. The main disadvantage of traditional smart textiles remains in the bulk volume of the attached rigid hardware equipment, which makes the user uncomfortable. To overcome this problem, the main idea is to minimise the hardware size, make it compatible with the textile structure and integrate the electronics into the textiles directly.

The prototype is tested in indoor/outdoor environment. All the physiological data are transmitted into a remote database server and an online monitoring system is used to supervise the physical state of the wearer.

The main advantage of this design is the new type of conductive junction, which is smaller and softer. The size of the conductive junction can be tremendously decreased down to 0.5mm*0.5mm compared with the current buckle junction. This novel design of printed electronics embedded textile technology leads the e-textile physiological monitoring system to a higher tendency of the washable, flexible, stretchable and thin characteristic of the pure textile.

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Dr. Tzu-Hao Huang is a researcher at the smart textile section, Department of Product of the Taiwan Textile Research Institute. He is currently responsible for the research in the smart textile technology. He obtained his PhD in Mechanical Engineering oat the National Taiwan University in 2013. His research interests lie in smart textiles, biomedical applications, machine learning, and robotics.

Inotek TM non-woven

Veronika KAPSALI

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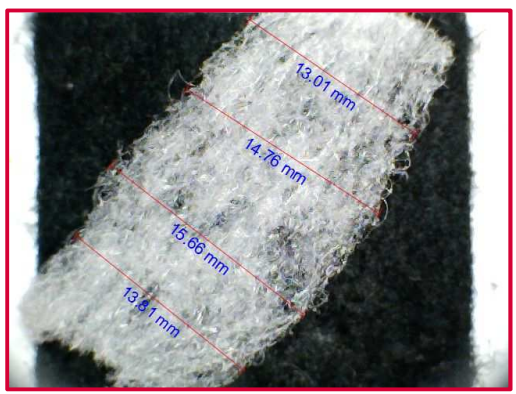

A non-woven textile made from Inotek fibres is designed to contract in length as it absorbs moisture and it returns to its original dimensions when dry. As a result this prototype non-woven contracts in x, y and z directions in response to damp conditions and returns to its original size when dry.

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Dr Veronika Kapsali is a Reader in Material Technology and Design at LCF where she is developing novel biomimetic approaches to design and innovate within the textile industry that intersects with biology, material engineering and textile design. Veronika is an LCF graduate who was awarded a PhD scholarship to study engineering design at Bath University. Her practice intersects academic and manufacturing sectors both within her role as Reader and as co-director of MMT Textiles Limited and inventor of INOTEK ™ (an award winning biomimetic textile platform that draws on ambient moisture to trigger reversible mechanical changes in the fabric structure, typically for advanced moisture and insulation management). Veronika is also research co-ordinator for the School of Design and Technology and co-coordinator of the college PhD community.

She is a bestselling author in industrial design and works extensively with private and public organisations on clothing comfort, performance and advanced functionality on an international scale.

Controllable LEDs Textiles

ensait
Ecole Nationale Supérieure des Arts et Industries Textiles

Ya-Chi KO, Tzu-Hao HUANG, Xuyuan TAO, Hou-Sheng HUANG, Wei-Chun WANG, Chien-Lung SHEN, Gwo-Tsuen JOU, Vladan KONCAR

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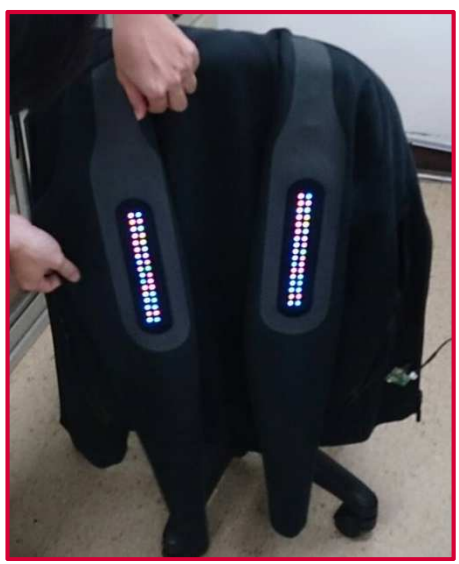

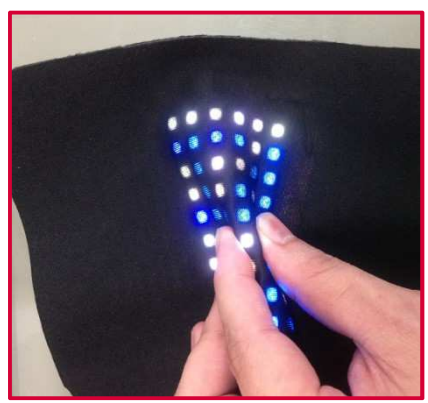

This prototype is made by integrating a printed circuit board and LEDs into a fabric for lighting applications. The LEDs circuit board is made by printing elastic conductive silver ink on TPU (Thermoplastic Urethane) and the LEDs are glued with the silver junction by anisotropic conductive film directly. The main advantage of this design is that the new type of conductive junction is smaller and softer and the LED modules are easy to integrate into the textiles by the process of heat and pressure. The controllable LEDs Textiles can display any kind of pattern and change the pattern by cell phone application in real time. In the future, it can be used in safety and fashion garments. This novel design of the LEDs embedded textile technology creates a new way to achieve better properties of washability and flexibility for smart textiles.

Yachi KO currently works as a project manager in smart textile projects in the Taiwan Textile Research Institute (TTRI). She is involved in several projects including a smart fire fighter clothing system, textile-based circuitry which focuses on design management design policy, design-led innovation, and service design. Recently, she worked at a quality design for medical grade smart clothing. It is a great achievement to process technology commercialization in management.

(A)dressing Stigma

Royal College of Art
Postgraduate Art and Design

Marion LEAN

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Is there something wearable that could be used to discourage social stigmas of health? Critical clothing that might protect and equip socially and serve as armour from environmental and societal pressure, expectations and dangerous barriers to change.

If we don't support people to make healthy choices by shaming and under designing suitable active wear we have no hope in leading change. If people can't find the right clothes to fit, or 'fit in' it does not encourage healthy, happy interaction, attitude or behaviour.
Anti Stigma Jacket - Fully reflective material perfectly mirrors surrounds, creating a safe space to hide while your peers see only their perfect self-portraits projected back. Rather than create an invisible cloak, the garments allow the dangerous obesity risks created by trends in your environment to seemingly fit you, or alternatively when this low tech smart technology is held to a light source it becomes instantly transparent, revealing the true body beneath.

Marion Lean is currently undertaking a practice led PhD in the School of Materials at the Royal College of Art. Her work aims to encourage ways of reconceptualising the body and the potential of the use of clothing for improved health management and monitoring.

Inter-fashionality

Mingjing LIN, Yingjun LI

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Under the influence of Parametricism in the current digital culture, textiles as a design tool, mediates the interrelationship of garment, body and movement, becoming the second skin of humans.

Qipao is a traditional Chinese dress that was, originally, designed as wide and loose. The shape of the garment changed from the 1920s when Shanghai became the centre of Eastern trade and local tailors continued shaping, using ironing rather than darts.

Digital fashion seeks both the technical and conceptual innovation. 3D Printing is one of them. Similar to the Qipao history, the specific tailors' skill of making and ironing techniques differentiates the understanding of body, dress and the space in between. This speculative and collaborative research, Textile the Skin, asks how traditional knowledge of the Qipao can be interpreted through new techniques of 3D printing, in order to celebrate the innovation made possible by mechanical systems and to re-consider the traditional handcraft knowledge under digitization.

Mingjing Lin, a PhD researcher at RCA School of Material, explores how 3D printing enables new forms of customization, bespoke manufacture and mass making. With cultural exchange as the core of the project, the new garments echo tradition in the way they are also sustainable, as they follow a continuous pattern there is little waste. And inspired by "one-piece" concept and Chinese ironing techniques, the new designs are printed by SLA and FDM techniques and fitted to the body, creating beautifully interactive movement between garment and dancers.

Mingjing Lin is a doctoral researcher in textile and fashion at the Royal College of Art in London. She graduated from Tsinghua University and London College of Fashion, major in fashion design and fashion design technology (womenswear) respectively. Her current research focuses on 3D-printed textile for fashion design.

Thermoresponsive textile demonstrator

Hochschule
Albstadt-Sigmaringen
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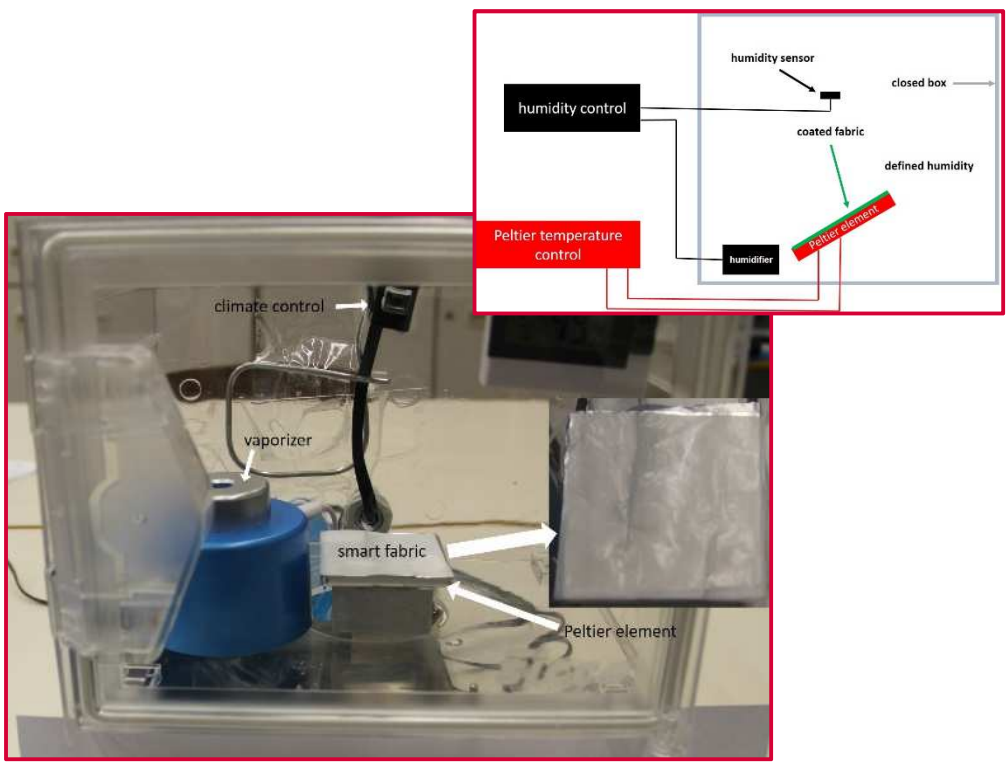

The demonstrator consists of a two-dimensional thermoresponsive functionalized woven fabric which represents a model for a prototype of a clothing with functionality on the nano- and microscale. Therefore, the demonstrator has to be scaled up to visualize the effect. The two-dimensional woven fabric can be considered as a part of a clothing, which reveals its functionality as soon as a warmed sweating person wears this clothing. The smart function lies in controlling the heat and humidity transport from the body to the environment.

The fabric is placed on a heatable element, which controls the temperature from room temperature to a temperature in the physiological regime (30-40°C). Since the response depends on humidity, a vaporizer shall control the relative humidity (rh) from 50 to 90 %. This combination of heater and vaporizer exemplifies a skin model. All parts are included in a transparent climatic chamber.

The visible smart effect of the demonstrator is a change of the optical transmittance of the coated textile in dependence on temperature and humidity. It shows the mechanism of conformational changes of the thermoresponsive polymers by opening and closing its pores.
The transparent appearance coincides with a hygrothermally isolating state, whereas the opaque appearance coincides with a heat and humidity permeable state.

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Pressure Map System

Riccardo MARCHESI, Amedeo EBOLESE

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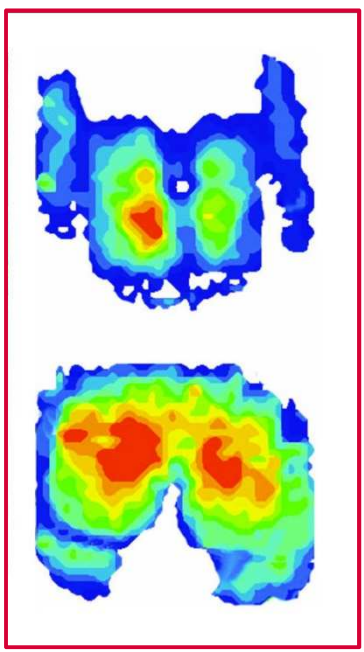

Pressure Map System is based on textile sensors able to detect tactile pressure with precision. This system is particularly studied for chairs and car seats. One sensor is placed on the seat, the other one is placed on the back rest.
The hardware and software transform the electrical signals generated by the sensors into a coloured map shown on the screen of a PC. The advantage of using knitted fabrics to make the sensors is that, unlike sensors made of plastic films, they are extremely conformable to uneven surfaces, thus being able to adapt to many shapes a soft object can take. The software allows customization and controls.

Riccardo Marchesi holds a degree in electronic engineering. Since 1987 he works for his family company, formerly SCOMAR Srl to produce knitting machines. In the year 2000 Riccardo and his brother transformed the company to produce metal fabrics for EMI shielding and interior design. In 2016 Riccardo co-founds Plug&Wear Srl, a startup dedicated to the development and production of textile sensors. He is the inventor of three patents.

Amedeo Ebolese holds a degree in astrophysics. Being an innovation enthusiast, since 2009 he collaborates as application scientist and developer in several projects as: development of sensors for nuclear physics; supervision systems of laser machining for aerospace industry; multispectral imaging of paintings for art restoration to remote sensing and image interpretation for archaeological research. Since 2017, Amedeo cooperates with Plug&Wear Srl, start-up dedicated to the development and production of textile sensors.

Tranquilitie

Galina MIHALEVA and Diego GONZALEZ

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Through her Tranquilitie project, artist Galina Mihaleva wants to focus on a different kind of pollution that has nothing to do with air: noise pollution and the physical and mental health effects of all those who suffer from it (hypertension, stress, tinnitus, sleep disorders). Aiming to reconnect its wearer to a calmer and more serene environment, the Tranquilitie dress connects to the calmest places on the planet in real time. In order to make this research visible, the garment has a display area, composed of sensors and LEDs, which displays the state of noise pollution in a city. The lights illuminate, reacting and blinking in different patterns depending on the intensity and the volume of the city being analysed. The dress is complemented by a virtual reality helmet, which strives to offer a more immersive experience.
Through this project, the artist questions our ability and desire to move away from over-stimulation.

Galina Mihaleva is an Assistant Professor at the School of Art, Design and Media at Nanyang Technological University, where she teaches Technology, Art and Fashion. Her work and research deal primarily with the dialogue between body and dress, driven by the idea of having both a physical and a psychological relationship with a garment as a responsive clothing - wearable technology. Her art and design work has been shown in festivals, galleries and musea across the United States, Asia, Central and South America and Europe. Unbounded by the old rules, Galina now offers her work as a testimony to the power of beauty and expression, and to the transcendent human spirit. She regards her works as being timeless.

Textile-based hybrid photovoltaic/thermal system

Barbara PAUSE

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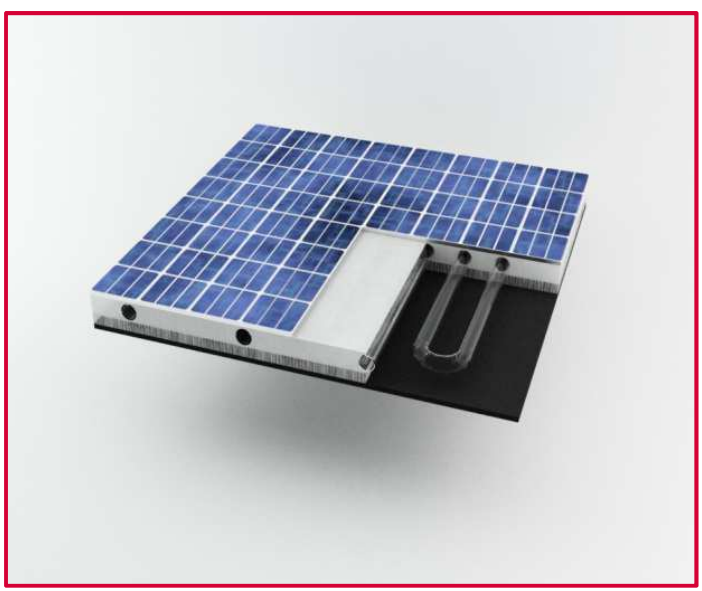

The textile-based hybrid photovoltaic/thermal (PV/T) system consists of a spacer fabric in which thin pipes are integrated. The back side of the spacer fabric is covered with a protective coating in order to withstand the elements. The front side of the spacer fabric faces thin film PV cells and is coated with a silicone compound containing phase change material (PCM) as a thermal storage means. During the coating procedure, the silicone compound penetrates into the spacer fabric and encloses the pipes completely. The thin film PV cells are laminated on top of the silicone layer. The photovoltaic process generated in the thin film PV cells converts solar radiation into electricity. As soon as the temperature of the PV cell exceeds a given trigger temperature, the excessive heat is absorbed by the PCM integrated in the silicone compound. In this way, the PV cell is cooled and can operate at its optimal temperature, staying at its highest possible efficiency and maximum electrical output. The absorbed heat is stored in the PCM and is released, then water is pumped through the pipes. This process recharges the PCM for the next cycle of heat absorption and generates hot water as well. The hot water can be used instantly or can be stored in an intermediate hot water tank.

Dr. Barbara Pause is president of Textile Testing & Innovation, LLC. – a company which is specialised in the development and testing of products equipped with phase change material (PCM). The company is located in Longmont, Colorado (USA).

ZigBee-based Firefighter Smart Protection Garment System

Vladan KONCAR, Xuyuan TAO, Tzu-Hao HUANG, Gwo-Tsuen JOU, Chien-Lung SHEN, Romanos FYROGENIS, Andriotis KONSTANTINOS, Dimitrios GOUSTOURIDIS, Savvas VASSILIADIS, Yusuf SAGLAM

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The firefighter smart protection garment is based on three different modules (underwear, uniform and terminal computer). The underwear module can capture the body temperature, humidity, accelerometer, gyroscope and ECG data. The uniform module will capture the environment temperature. The terminal module is connected to a computer in order to send the data to an online database server. The information between the three modules is transmitted under a ZigBee protocol. The underwear and uniform modules are encapsulated in order to satisfy the washability requirement.

A remote monitoring system is used to analyse the date online. This monitoring system is based on an artificial intelligence classification model, which can quickly identify the firefighter in danger according to the received data.

Vladan Koncar and **Xuyuan Tao** work in ENSAIT (Ecole Nationale Supérieure des Arts et Industries Textiles), France, Tzu-Hao Huang, Gwo-Tsuen Jou and Chien-Lung Shen work in TTRI (Taiwan Textile Research Institute) in Taiwan, Romanos Fyrogenis and Andriotis Konstantinos work in TMET (TEXNOLOGIES FOTONIKON KAI HLEKTRONIKON SYSTHMATVN AE) in Greece, Dimitrios Goustouridis and Savvas VASSILIADIS work in TEIP (Technological Educational Institute of Piraeus) in Greece, Yusuf Saglam works in Kivanç in Turkey.

Luminous Slippers

Nese TOPCUOGLU, Bahar Burcu AYTEKIN, Gozde GONCU-BERK

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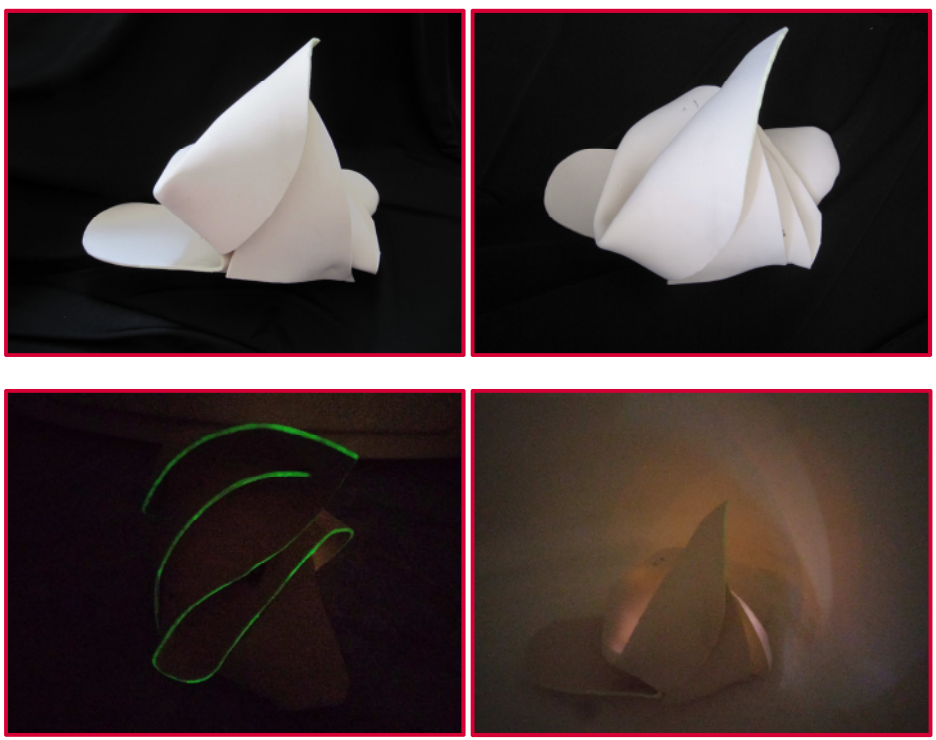
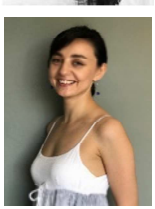


Luminous Slippers are functionally designed for lighting up the way during the night and involving light into dressing aesthetics. Bioluminescent ocean species inspired this work. LED embedded EVA and its luminous borders create a sense of a Hawaiian Bobtail Squid.

The aesthetics of the draped structure hide the electrical circuit and enable percolation of light ahead the way; disable dazzling the eyes and disturbance of the surrounding. It provides a certain direction to the percolating light beam. On the other hand, illuminated drape gives lustered appearance to the textile. Luminescent borders applied by photo phosphorescent material direct the user to find the slipper in the dark and put on the right side.
The illumination on the slipper can be activated by touching to the floor or wall with the front sides via the push button embedded on the front side of the slippers. This movement for activation is easy, user friendly; does not require to bend back or touch with hand. The slipper includes sewable LED components, a sewable switch, sewable battery holder and conductive thread. The inactivated Luminous Slippers are also chic accessories during the day time.



Nese Topcuoglu is studying the Master of Science in Textile Engineering Program of Istanbul Technical University and graduated from the Industrial Product Design Department of the same university. She is interested in designing of textile based electronic and functional wearables.

Bahar Burcu Aytekin studied Material Science and Engineering (B.Sci & M.Sci) in Sabanci University/Turkey and Applied Mechanical Science in Lulea Technical University. She worked in carbon nanotube research in the Max Planck Institute/Germany; and she was involved in the Advanced Materials Science Program in the Technical University of Munich. After academic education, she positioned herself in functional design as the assemble of material science and art.

Dr. Gozde Goncu-Berk is an Assistant Professor at the Istanbul Technical University, College of Textile Technologies and Design and vice department head of the Textile Engineering Department. Her research interests are new product development processes, functional apparel design, wearable products for healthcare applications, sustainability and cross-cultural aspects in apparel design.

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