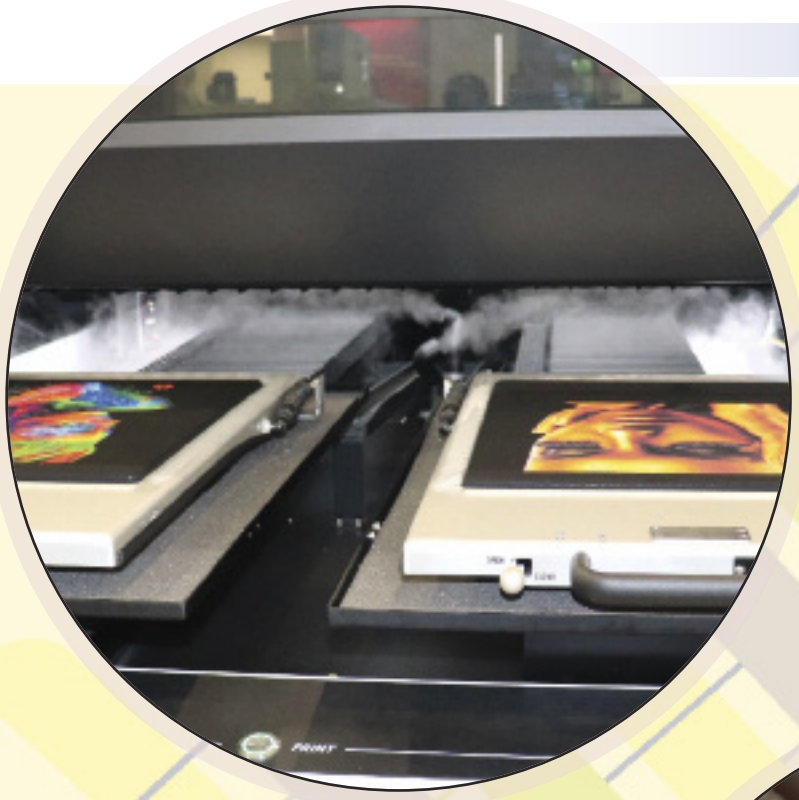
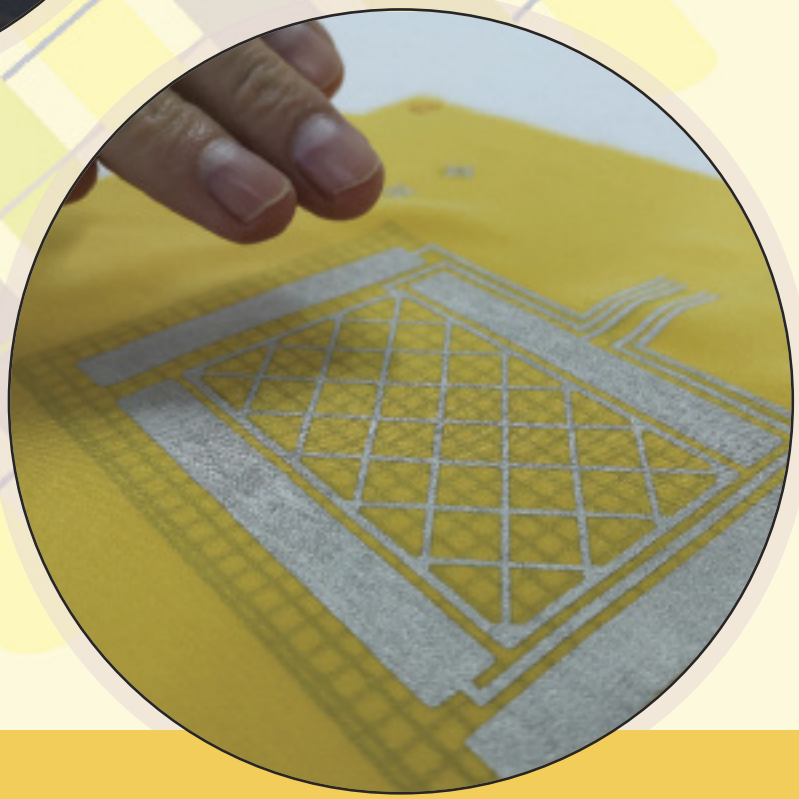
Technical TEXTILES international

August 2019
Volume 28, Number 4

Informing the industry worldwide



Digital innovation is stimulating brisk business for print machinery



Learn how to print sensors onto stretchable substrates

INSIDE:

Outdoor Retailer continues to focus on sustainability

Why China's carbon fibre industry is set to flourish

High-performance monofilaments based on biopolymers

Technical TEXTILES international

Published continuously since 1992, ***Technical Textiles International*** is **THE** foremost magazine dedicated to all aspects of the international technical textiles industry.

It is relied upon by senior executives for the latest on new products and processes, technologies, markets and applications for the advanced and high-performance textiles and nonwovens industry.

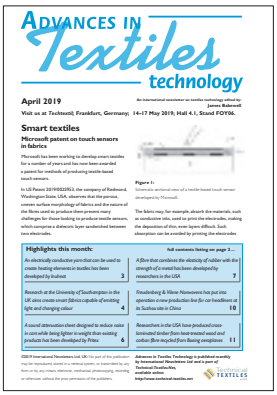
Technical TEXTILES .net

Since its launch as a subscription service in 2015, **Technical-textiles.net** has provided a unique one-stop online information source for all areas of technical and advanced textiles, high-performance nonwovens and advanced composites.

Every item is written or edited by experts in the field, ensuring the readership sees TTNet as an authoritative and trustworthy information source.

Your partners in technical textiles

Our range of publications on advanced textiles, nonwovens and composites



PLUS Industry Reports and Conferences

for full details on our product range and to download free sample publications, visit www.technical-textiles.net

IN INTERNATIONAL NEWSLETTERS

Technical TEXTILES .net

Advanced Composites Bulletin

The International Newsletter Dedicated to the Use of Advanced Composites

- Provides you with **everything you need to know about advanced composites.**
- Looks at **technology trends**, new applications, new research and products.
- Covers **all application areas** including automotive, construction and aerospace.
- Contains **contact details** so you can follow up articles of interest with those concerned.
- Keeps you **up-to-date** with the latest news.
- Each issue looks at a **specific technological trend** in the use of advanced composites.
- A subscription gives you the **monthly printed newsletter** straight to your desk **plus online access** to the news service, articles and back issues.

For more information and to download your free copy visit:

www.technical-textiles.net

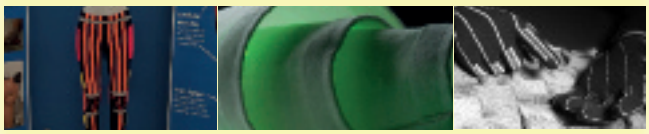
INTERNATIONAL NEWSLETTERS

advanced composites

Technical TEXTILES .net

Smart Textiles and Nanotechnology

The News Service For Textiles Futures



- Provides **both online and in print** the latest news on 'functional fabrics'.
- Reports on **wearable electronics, smart fabrics, nanofibres, nanocoatings, electrospinning, phase change and sensing materials** and more.
- Keeps you up to date on **company news, new products, R&D, and acquisitions.**
- Covers **new applications**, **new materials and products** from around the world.
- Contains **contact details** allowing you to follow up articles of interest with those companies and institutions concerned.
- Delivers the latest news on **markets and corporate strategies** worldwide.
- Describes **new materials** available for commercial use and how to exploit them.
- A subscription gives you the **monthly printed newsletter** straight to your desk **plus online access** to the news service, articles and back issues.

For more information and to download your free copy visit:

www.technical-textiles.net

INTERNATIONAL NEWSLETTERS

future textiles

Technical TEXTILES international

August 2019
(Volume 28, Number 4)

Editor: Nick Butler

Tel: +44 (870) 165-7210

Email: tti@intnews.com

Nonwovens Editor:
Adrian Wilson
Composites Editors:
Amanda Jacob and
James Bakewell
US correspondents:
John W. McCurry and
William C. Smith
Asian correspondent:
Vicky M. Sung
Indian correspondents:
Samuel Joseph and
Reena Mital
Regular contributors:
Geoff Fisher
and Niki Tait

Display advertising sales:
David Kay/Maria Box
Tel: +44 (1273) 423512
Email: dkay@fastnet.co.uk

Published by International Newsletters Ltd, 44 Friar Street, Droitwich Spa, Worcestershire, WR9 8ED, UK.

Subscription enquiries, orders and payments:
International Newsletters Ltd, 44 Friar Street, Droitwich Spa, Worcestershire, WR9 8ED, UK.
Tel: +44 (870) 165-7210
Email: sales@intnews.com
http://www.technical-textiles.net

Annual subscription (six issues): includes free access to publications and back issues online: £300/$459/€390.
(Payments in other currencies are subject to our prevailing exchange rate). Prices are valid to the end of 2019, and include airmail delivery in Europe and air-speeded delivery elsewhere.

In the Editor's opinion

What has a busy year taught us so far?

Following an unusually busy period in the industry's exhibition schedule – with in particular *Techtextil/Texprocess* (held in Frankfurt, Germany, on 14–17 May 2019) followed by *ITMA* (Barcelona, Spain, on 20–26 June 2019) – we can now pause and take a moment to consider what these events have taught us.

Three key themes remain prominent: the continuing rise of digital printing; the need for textile manufacturers to reduce their negative impact on the environment—sustainability; the focus on the automation of and data-exchange between processing technologies—Industry 4.0. These drivers will be at the forefront of the industry's development for many years to come.

Digital printing has already taken centre stage in several recent issues: *Digital innovation stimulates good business for print machinery*, this issue, page 15, where Adrian Wilson reports on the innovations displayed in Barcelona and on the encouraging volume of sales made directly on the show's floor; *Innovations in digital printing continue at a rapid pace*, June 2019, page 35, where James Bakewell describes other technology developments revealed during *FESPA Global Print Expo* (held in Munich, Germany, on 14–17 May 2019) and subsequently exhibited at *ITMA*; *Digital printing continues to drive innovation among manufacturers*, May 2019, page 55, where Adrian Wilson reviewed the technology displayed by exhibitors at *Heimtextil* (held in Frankfurt, Germany, on 8–11 January 2019).

Digital printing's use to apply functional treatments to textiles, in contrast to decoration, is at a relatively elementary stage, but there was clear evidence at *Techtextil* in particular that this is about to change (*Finishing, and coating and laminating to create functional textiles*, May 2019, page 37).

The evolution of digital printing is just one way the industry is trying to reduce its use and waste of resources (water, chemicals and energy) and so address the demands from consumers and legislators for sustainable manufacturing. Many others were the subjects of innovations revealed during *ITMA* (see our complete set of previews in the June 2019 issue, pages 4–45, and Adrian Wilson's round-up of all the other major technology developments from Barcelona in our October 2019 issue). Also in that forthcoming issue, Wilson will review all the Industry 4.0-related innovations presented at *ITMA*.

Finally, in this issue we also report on two research projects whose goals were clearly influenced by the themes described above: *Learning how to print sensors onto stretchable substrates*, page 31; *High-performance monofilaments based on advanced biopolymers*, page 35.

The exhibition schedule might now be quieter for some time, but *Technical Textiles International* will of course continue to keep you informed of these and all relevant developments.

Technical TEXTILES international

Contents

August 2019

4 **Nonwovens update**
Efficient radio-frequency drying for nonwoven battings and foams • Black plastic replaced with cellulose fibre in trays for ready meals • Nonwoven wheelarch liners absorb noise

6 **Fibres update**
Industrial-scale electrospinning equipment for medical applications • Argonne builds electrospinning properties database

7 **Business update**
Unifi places order for latest yarn texturing machine from Oerlikon • Sustainability and digitization to be key themes at *Dornbirn* • Early sales success at *ITMA* for Saurer's latest air-spinning machine • Karl Mayer targets China with digital technologies • Rieter awarded large contracts from Egypt at *ITMA* • Chemical industry organizations align to promote sustainability • HP makes *ITMA* debut and opens digital manufacturing centre • Hyosung and Saudi Aramco look to build carbon fibre plants

10 **Smart textiles update**
Textile-based lithium battery shows promise for wearable electronics • Smart textile series production first shown at *Techtextil/Texprocess*

12 **Composites update**
Braided carbon composite spaceframe for lightweight railway carriages • Start-up has lofty ambitions for composites production process • Closed-loop recycling of carbon composites for the marine industry • Manufacturer of high-performance carbon fibre reinforcement secures backing • Glass fibre-reinforced thermoplastic seat shell is developed for Audi

In depth: Digital printing
15 Digital innovation stimulates good business for print machinery

Review: *Outdoor Retailer Summer Market*
21 *Outdoor Retailer* continues to hold the torch for sustainability

In depth: Carbon fibre in China
25 China's carbon fibre industry is now positioned to flourish

In depth: Smart textiles
31 Learning how to print sensors onto stretchable substrates

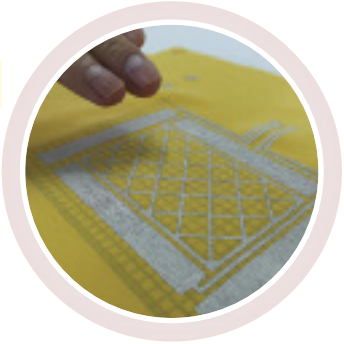
In depth: Biopolymer fibres
35 High-performance monofilaments based on advanced biopolymers

39 **Events diary**

40 **Index to advertisers**

On the cover:

Exhibitors of digital printing technology at the latest ITMA did brisk business writes Adrian Wilson, starting on page 15.



Beginning on page 31, Spanish researchers reveal how to select the best substrates, inks and deposition methods for printing sensors onto textiles.

Technical TEXTILES international

Further information at http://www.technical-textiles.net

Efficient radio-frequency drying for nonwoven battings and foams

Radio Frequency Co's radio-frequency drying system can heat nonwovens throughout their entire thickness simultaneously.

A radio-frequency (RF) dryer for manufacturers of nonwoven battings and hydrophilic foams has been launched by Radio Frequency Co of Millis, Massachusetts, USA.

Producers of nonwoven battings and foams are faced with unique drying challenges owing to the insulative characteristics of these products.

Using conventional drying methods, long residence times are required to allow the heat to penetrate into the inner portion of these products and remove moisture.

Radio Frequency Co says that RF drying systems can heat these products throughout their entire thickness simultaneously and remove the moisture by converting it to gas *in situ*. This greatly reduces drying times and significantly increases the energy efficiency of the drying process.

Further, because the moisture is turned into gas *in situ*, the migration of suspended solids such as binders, anti-microbial agents and colours, within the nonwoven is eliminated. This prevents the formation of a surface crust and enhances the uniformity, performance and hand-feel of the products.

The RF drying process generally takes place at low temperatures (lower than 100°C), which makes it suitable for use with temperature-sensitive materials.

However, for formulations that require higher temperatures to cure or cross-link polymers, systems can be supplied with integrated hot-air modules.

Lisa Mitchell, Market Development Manager, Radio Frequency Co.
Tel: +1 (508) 376-9555.
Email: LMitchell@radiofrequency.com;
https://radiofrequency.com

Black plastic replaced with cellulose fibre in trays for ready meals

The Fresh tray, which is manufactured using cellulose fibres from Södra.

Recyclable and compostable ready-meal packaging made from cellulose fibres has been adopted by a UK supermarket as it looks to stop using polyethylene terephthalate (PET) versions. Waitrose & Partners of Bracknell is packing its Italian ready meal range in the fibre-based tray, which is called Fresh and is manufactured using fibres from Södra of Växjö, Sweden, by food packaging specialist Huhtamaki of Espoo, Finland.

Fresh is the result of a project started in 2016 with the aim of finding alternatives for food packaging trays made from black plastic, usually crystalline PET. Huhtamaki Project Manager Steve Davey says that this petrochemical-based plastic is difficult to recycle owing to its incompatibility with the detection systems used to separate materials in recycling centres.

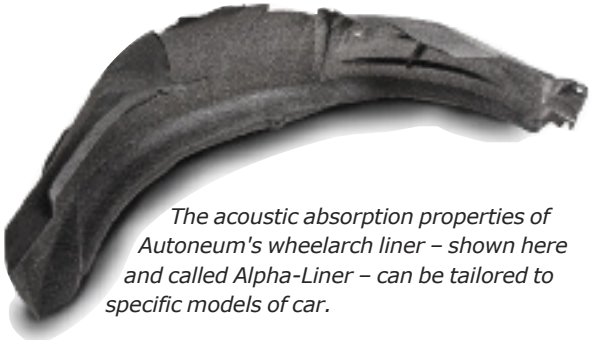
Packaging Development Manager from Waitrose & Partners, Nikki Grainge, says: "We have made a commitment to move out of black plastic by the end of 2019. We have been testing the new trays since May 2018 and have received very positive feedback from our customers."

With the launch of the Italian range, some nine million meals will be packed in Fresh trays.

Steve Davey, European Project Manager Fresh, Huhtamaki.
Mobile (cellular): +44 (7) 80236-4792.
http://www.huhtamaki.com/en/fresh

Johannes Bogren, Technical Product Director, Södra.
Tel: + 46 (76) 840-0710.
Email: johannes.bogren@sodra.com;
https://www.sodra.com

Nonwoven wheelarch liners absorb noise



The acoustic absorption properties of Autoneum's wheelarch liner – shown here and called Alpha-Liner – can be tailored to specific models of car.

A lightweight polyethylene terephthalate (PET) fibre-based nonwoven wheelarch liner that absorbs tyre noise has been launched by Autoneum of Winterthur, Switzerland.

The acoustic absorption of the compression-mouldable liner, called Alpha-Liner, can be tailored to specific models of car. This is achieved by changing the porosity of a thin plastic coating that is applied to the liner on its tyre-facing side.

Autoneum says that reducing the external noise generated by the tyres of vehicles will be crucial as regulations on this pass-by noise become increasingly stringent. From 2024, newly registered vehicles in the European Union (EU) will be allowed to generate a maximum of 68 dB of external noise, a challenge for manufacturers and suppliers alike, given that the current threshold is 72 dB and the acoustics of vehicles have already been highly modified in order to meet it.

Autoneum claims that its Alpha-Liner wheelarch liners are easy to clean, resistant to stone chipping and ice accumulation, and are lighter than conventional plastic liners, contributing to increased driving range for electric vehicles. Further, the PET fibres used to produce the liners are primarily recycled and any scrap from the production of the liners can be re-used.

Alpha-Liner was unveiled at the *Automotive Acoustics Conference* in Zurich on 9–10 July 2019.

The effects of regulation on the use of textiles in automotive applications will likely be a topic of discussion at the first edition of *Textile Opportunities in a Changing Automotive Industry*, which will take place in Birmingham, UK, on 5–6 February 2020 (see also, outside back cover).

Anahid Rickmann, Head Corporate Communications and Responsibility, Autoneum.
Tel: +41 (52) 244-8388.
Fax: +41 (52) 244-8336.
Email: media.inquiry@autoneum.com;
http://www.autoneum.com

Jill Gwinnutt, Marketing Manager, Textile Opportunities in a Changing Automotive Industry.
Tel: +44 (0)870 1657210.
Email: jill.gwinnutt@intnews.com;
https://www.technical-textiles.online/TOAI

Industrial-scale electrospinning equipment for medical applications

A company specializing in electrospinning equipment to make fibre-based medical materials claims its latest unit (MediSpin XL) can reproducibly and continuously manufacture, on an industrial scale, scaffolds and membranes for applications in implants and regenerative medicine.

IME Medical Electrospinning, based in Waalre, The Netherlands, says the materials produced can be based on nano- to micrometre-scale biocompatible fibres, selected according to the specific end-use. Scaffolds can be made, for instance, to mimic the body's extracellular matrix (ECM)—the three-dimensional (3D) network of macromolecules that provides support to surrounding cells. The body perceives appropriately constructed and constituted artificial scaffolds as being natural, allowing them to be implanted to assist in the repair of damaged tissue, such as heart valves, blood vessels, nerves, tendons, skin and bone.

MediSpin XL is designed for industrial-scale manufacturing of such materials and ensures control of crucial parameters for the production of consistent end-products. Consistent fibre diameter and structure, and porosity, thickness and tensile strength of the mesh are vital for in-vivo products, but have been challenging to control until now. In particular, changes in temperature and relative humidity have previously led to inconsistencies within a batch, as well as between batches.

Drawing on more than ten years of experience developing small-scale equipment for research and development (R&D), IME says the MediSpin XL uses climate-control features and online quality monitors to keep the processing stable. In addition, it captures process data and is designed to minimize the possibility of contamination of the product, taking into account the strict regulations in place for manufacturers; for instance, it is highly automated to reduce the need for any operator intervention. Downstream processes, such as cutting, can also be added to the line.

Company founder Ramon Solberg says: "This technology enables the large-scale manufacturing of reproducible fibre-based scaffolds that will substantially transform the market for a wide variety of medical applications and revolutionize regenerative medicine."

IME Medical Electrospinning has developed an electrospinner that it says can reproducibly and continuously manufacture micro- to nanometre-scale biocompatible fibres.

IME also reports it has commissioned a new facility conforming to good laboratory practice (GLP) and a set of cleanrooms compliant with the International Standards Organization (ISO) requirements for Class 7. This investment will not only allow the company to develop and manufacture its electrospinning equipment, but also to produce scaffolds and medical implants for customers. The cleanroom facilities, for instance, allow IME to make medical materials compliant with Class I, II and III devices, according to the regulations of the European Union (EU).

Judith Heikoop, Managing Director, IME Medical Electrospinning.
Tel: +31 (40) 2827-956.
Email: j.heikoop@ime-electrospinning.com

Kevin van Erp, Account Manager, IME Medical Electrospinning.
Email: k.v.erp@ime-electrospinning.com;
https://www.ime-electrospinning.com

Argonne builds electrospinning properties database

The ability to capture data in real time as fibres form can make electrospinning techniques more affordable and effective, according to the US Department of Energy (DoE)'s Argonne National Laboratory of Lemont, Illinois.

Eelectrospinning processes can be used to produce nanometre-to-micrometre-diameter ceramic, polymer and metallic fibres for a wide range of applications including tissue engineering, filtration, fuel cells and lithium batteries. These fibres have unique properties owing to their high aspect ratios and large surface areas.

However, the development of electrospinning processes has largely been by trial and error, making them difficult to reproduce reliably in industrial settings. This challenge stems from a lack of understanding of the underlying dynamics of the process, which involves more than 10 control parameters (such as the voltage applied, working distance and the viscosity of the precursor).

To rectify this issue, researchers at Argonne, led by materials scientist Yuepeng Zhang, are building a database that can be used to identify correlations between the parameters of electrospinning machines and the properties of fibres produced. The database will allow companies to design fibres for specific applications quickly, while also enabling real-time feedback and control on the manufacturing floor.

The researchers are conducting *in-situ* X-ray measurements at the 12 ID-B x-ray scattering beamline at Argonne's Advanced Photon Source (APS), which enable them to gather real-time structural, physical and chemical information from fibres as they form and change during processing, facilitating correlation with processing parameters.

The database can also be adapted for use with roll-to-roll manufacturing processes, which involve continuous processing of a flexible substrate as it is transferred between two moving rolls of material.

Yuepeng Zhang, Principal Materials Scientist, Argonne National Laboratory.
Tel: +1 (630) 252-7927.
Email: yuepeng@anl.gov;
https://www.anl.gov

Unifi places order for latest yarn texturing machine from Oerlikon

At just 4.7 m in height, Oerlikon's eAFK Evo texturing machine still features a four-deck winding system and active cooling technology.

Oerlikon Barmag finished its first day at *ITMA* (in Barcelona, Spain; 20–26 June 2019) having received a significant order for its latest texturing machine (eAFK Evo) from Unifi Manufacturing Inc.

Unifi of Greensboro, North Carolina, USA, worked with Oerlikon of Remscheid, Germany, to develop a prototype of the machine and has been using it for the last eight months to manufacture various virgin (Unifiber) and recycled (Repreve[(1)]) polyester (PES) and polyamide (PA) yarns.

Unifi has obtained exclusive rights in the Americas to its unique design for the machine, which enables it to operate at high texturing speeds, produce high-quality yarns and be used to develop new performance yarns.

Unifi claims to have turned more than 16 billion plastic bottles into fibres for the production of apparel, footwear, home goods and other consumer products with the help of Oerlikon Barmag texturing machines. The company plans to recycle 20 billion bottles by 2020 and 30 billion by 2022.

At *ITMA*, Oerlikon exhibited a configuration of the eAFK Evo texturing machine designed for the cost-efficient production of commodity yarns. At just 4.7 m in height, this compact machine still features a four-deck winding system.

The most important parts of both configurations are the 300-mm-long controllable cooling unit (EvoCooler), which can process titres of around 30–300 denier – including microfilaments – and the EvoHeater, which increases texturing speed by about 20%, according to Oerlikon. The EvoCooler enables yarns to be dyed evenly, while the EvoHeater and its peripherals have been designed to use 25% less energy than similar technologies.

Oerlikon also exhibited Repreve yarns produced on the eAFK Evo pilot machine, together with fabrics made from them, on its stand at *ITMA*.

See also: [(1)]*Technical Textiles International*, September 2012, *Unifi takes the lead in the production of recycled polyester*, page 33; http://www.technical-textiles.net/node/462

André Wissenberg, Marketing, Corporate Communications & Public Affairs, Oerlikon.
Tel: +49 (2191) 67-2331.
Email: andre.wissenberg@oerlikon.com;
https://www.oerlikon.com/en/brands/oerlikon-barmag

Sharon Roberts, Executive Assistant, Investor Relations, Unifi Inc.
Tel: +1 (336) 316-5505.
Email: sqrobert@unifi.com;
http://www.unifi.com

Sustainability and digitization to be key themes at *Dornbirn*

The digitization of the supply chain for the production of textiles and the impact of the textiles industry on the environment will be key themes at the *Dornbirn Global Fiber Congress (Dornbirn-GFC)* in Austria on 11–13 September 2019.

Among the highlights:

- oceanographer Sarah-Jeanne Royer of the Scripps Institution of Oceanography in San Diego, California, USA, will present her findings on the degradation of plastics and microfibres in the world's oceans;
- Commercial Lead at Microsoft of Seattle, Washington, USA, Robert Rosellen, will give a presentation on the ways in which software can be used to manage recycling and sustainability initiatives;
- Security Researcher at Palo Alto Networks in Santa Clara, California, USA, Stefan Achleitner, will discuss the importance of cyber security for digital manufacturing operations.

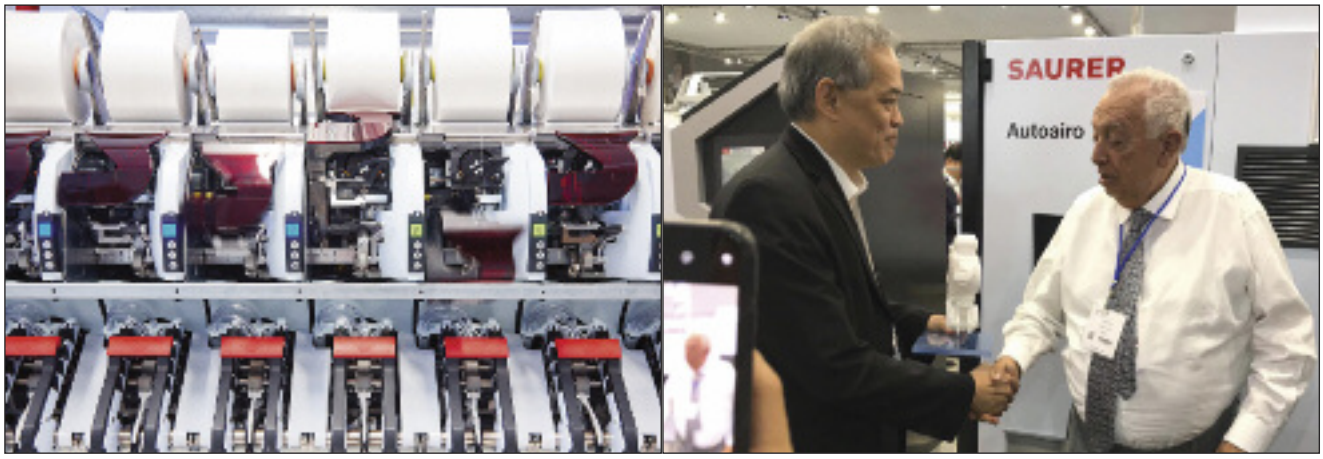
For the 58th edition of the annual conference, organizer the Austrian Fibers Institute of Vienna has worked with accountancy firm PricewaterhouseCoopers (PwC) of London, UK, to put together an event for new companies, 50 of which will give presentations.

During the main conference, meanwhile, the latest developments in technology for the fibre and textile industries will be presented by a line-up of over 100 speakers.

The 57th conference, held on 12–14 September 2018, included more than 100 presentations, and attracted over 700 participants representing 30 countries.

Dornbirn Global Fiber Congress Office.
Tel : +43 (1) 319-2909-41.
Fax : +43 (1) 319-2909-31.
Email: office@dornbirn-gfc.com;
http://www.dornbirn-gfc.com

Early sales success at *ITMA* for Saurer's latest air-spinning machine



Left: Up to four lots can be spun at the same time on Saurer's Autoairo air-spinning machine, and lots can be changed seamlessly during production. Right: Group Chief Executive Officer and Board Member at Saurer Group Clement Woon (left of picture) shakes hands with the first buyer of an Autoairo machine, Chief Executive Officer of Zagis, Mayer Zaga Galante Zagis (right of picture).

Saurer has already sold a number of its latest air-spinning machines, called Autoairo, which it launched at *ITMA* in Barcelona, Spain, on 20–26 June 2019.

The company of Wattwill, Switzerland, says that twenty-four piecing operations can be carried out simultaneously using Autoairo, meaning that it has the piecing capacity of competing machines. The Autoairo also requires 40% less space than air-spinning machines with a one-sided design, enabling greater productivity from factories with smaller floorspaces—reducing costs associated with construction and air conditioning.

Up to four lots can be spun on the Autoairo at the same time and lots can be changed seamlessly during production. Further, test packages can be manufactured while the other spinning positions continue with normal production. Finally, light-emitting diode (LED) strips at each spinning position signal, among other things, when cans need to be replaced soon—reducing the need for time-consuming tours of inspection.

The first Autoairo machine has been sold to Zagis of Tepeji, Mexico.

Contact: Simona Gambini, Head of Corporate Communications, Saurer Group. Tel: +41 (79) 425-3732. Email: media@saurer.com; http://www.saurer.com

http://www.zagis.com

Karl Mayer targets China with digital technologies

KM.ON Managing Directors Antonia Gottschalk and Maximilian Kürig.

Karl Mayer's digital technologies company KM.ON is establishing subsidiaries in mainland China and Hong Kong.

KM.ON of Frankfurt was set-up by Karl Mayer of Obertshausen (both in Germany) on 3 November 2017 to support its core machinery business and was initially called Karl Mayer Digital Factory GmbH[(1)].

KM.ON Managing Director Antonia Gottschalk says that the new subsidiaries will enable the company to focus on the specific needs of customers in China, while fellow Managing Director Maximilian Kürig points-out that businesses there are adopting digital technologies at a rapid pace.

See also: [(1)]*Technical Textiles International*, February 2018, Karl Mayer to focus on digitization, page 7; http://www.technical-textiles.net/node/73833

Contact: Ulrike Schlenker, Karl Mayer Textilmaschinenfabrik GmbH. Tel: +49 (6104) 402-274. Email: ulrike.schlenker@karlmayer.com; http://www.karlmayer.com

Rieter awarded large contracts from Egypt at *ITMA*

Rieter Group has signed seven contracts worth a total CHF180 million with the Cotton & Textile Industries Holding Co, Cairo (Egypt).

The contracts, part of efforts to modernize the Egyptian textile industry (see also, page 18), will see Rieter of Winterthur, Switzerland, deliver a number of compact- and ring-spinning systems over the next two years. The contracts were signed by the Chairman of Cotton & Textile Industries Holding Co, Ahmed Moustafa Mohamed, and the Chief Executive Officer (CEO) of Rieter, Norbert Klapper, at *ITMA* in Barcelona, Spain, on 20–26 June 2019.

Contact: Kurt Ledermann, Chief Financial Officer, Rieter Holding Ltd. Tel: +41 (52) 208-7015. Email: investor@rieter.com; http://www.rieter.com

Chemical industry organizations align to promote sustainability

Following a year of discussions, the Global Chemical Industry Round Table (GCIRT) and the Zero Discharge of Hazardous Chemicals (ZDHC) Foundation have agreed to work together to promote the widespread implementation of sustainable chemistry and best practices in the textile, leather and footwear industries.

The textile industry is under increasing pressure to minimize its impact on the environment and improve the sustainability of supply chains.

The Roadmap towards ZDHC demands that hazardous chemicals are eliminated from textile supply chains by 2020, to be replaced by greener alternatives. GCIRT, meanwhile, is a group of chemical suppliers with the goal of making the textile and leather industries more environmentally sustainable.

As a consequence of the agreement, the GCIRT signatory companies will each join the ZDHC Foundation and upload their products to the Chemical Module of the Internet-based ZDHC Gateway using the Finder tool from bluesign of St. Gallen, Switzerland.

The members of GCIRT are: Archroma of Reinach, Switzerland; CHT Germany GmbH of Tübingen; Colourtex Industries Private Limited of Surat, India; DyStar Singapore Pte Ltd; Huntsman Textile Effects of Singapore; KISCO of Seoul, South Korea; Pulcra Chemicals Group of Geretsried, Germany; Rudolf GmbH, also of Geretsried; Tanatex Chemicals BV of Ede, The Netherlands.

Chief Executive Officer (CEO) of Archroma, Alexander Wessels, says: "I believe that this intensified collaboration between all stakeholders in the supply chain will strongly accelerate the adoption of dye and chemical manufacturing innovations and processes to help minimize risk to the consumer and the environment."

The CEO of DyStar, Eric Hopmann, concurs: "A holistic approach towards sustainability is needed, considering all counterparts and stakeholders, to put some real positive impact on businesses, people and the planet.

Separately, bluesign has announced that will offer free access to Finder, which includes over 120 00 third-party verified commercially available textile dyes and auxiliaries, and more than 25 000 evaluated chemical products, from approximately 170 chemical suppliers.

Frank Michel, Executive Director, The Zero Discharge of Hazardous Chemicals (ZDHC) Foundation.
Email: roadmap@zdhc.org;
http://www.roadmaptozero.com

bluesign technologies ag.
https://www.bluesign.com

Muriel Werlé, Archroma.
Tel: +65 68667422.
Email: muriel.werle@archroma.com

Archroma Management GmbH.
Tel: +41 (61) 7163-466.
Fax: +41 (61) 7163-578.
Email:
textile.specialties@archroma.com;
http://www.bpt.archroma.com

Moon Tang, Global Corporate Communications, DyStar.
Tel: +65 6671-2897. Fax: +65 6659-1327.
Email: tang.moon@dystar.com;
http://www.DyStar.com

Hyosung and Saudi Aramco look to build carbon fibre plants

Hyosung Corp of Seoul, South Korea, and Saudi Aramco of Dhahran, Saudi Arabia, have signed a memorandum of understanding (MOU) for the building of carbon fibre plants.

Under the MOU, signed on 25 June 2019, the companies will consider plans to build the plants in Saudi Arabia and South Korea.

Since 2013, Hyosung has operated a carbon fibre plant in Jeonju, South Korea, with an annual production capacity of 2 kt. In February 2019, the company started construction of another carbon fibre plant in Jeonju with the same capacity.

Paul Kennedy, Business Development Manager, Hyosung Advanced Materials Corp.
Tel: +1 (603) 964-4152.
https://www.linkedin.com/in/paul-kennedy-7a92b017;
http://www.hyosungadvancedmaterials.com

https://www.saudiaramco.com

HP makes *ITMA* debut and opens digital manufacturing centre

Hewlett-Packard (HP) of Palo Alto, California, USA, has opened a three-dimensional (3D) printing and digital manufacturing centre in Barcelona, Spain.

With approximately 14 000 m^2 (150 000 square feet) of space, the Three-Dimensional Printing and Digital Manufacturing Centre of Excellence is a large-scale factory environment where HP can work with its customers and partners to develop digital manufacturing technologies. The facility features a flexible layout, co-development areas and fleets of the latest HP 3D printing systems for plastics and metals.

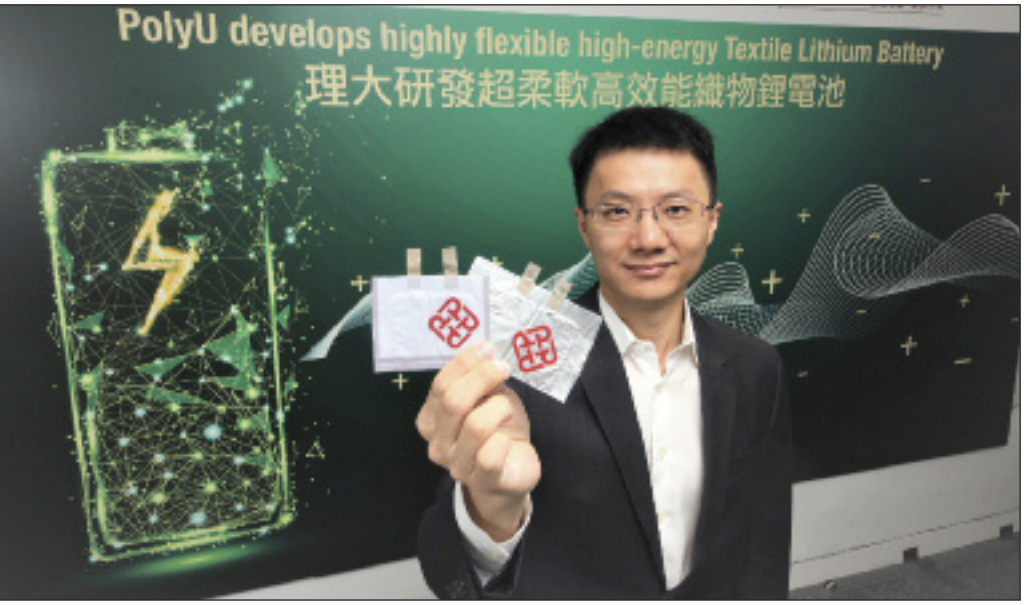
Companies such as BASF, GKN Metallurgy, Siemens, Volkswagen and others across the automotive, industrial, healthcare and consumer goods sectors will work with HP on new 3D printing and digital manufacturing technologies at the centre.

HP made its debut at I*TMA 2019* in Barcelona, Spain, on 20–26 June, where it introduced the Stitch S Series portfolio of wide-format printers (see also, page 15). The company believes that the textile printing market will grow in value from US$3.6 billion in 2018 to $5.5 billion by 2025. Its Stitch S Series range is designed to improve colour accuracy, reduce lead times and lower costs for print service providers compared with conventional technologies.

Terence Raghunath, Business Development Manager Decoration, HP.
Mobile/cellular: +34 (606) 910319.
Email: Terence.raghunath@hp.com;
http://www.hp.com

Michelangelo Petrarca, Brand Management Group for HP Large Format Media.
Tel: +34 (93) 547-9700.
Email:
michelangelo.petrarca@globalbmg.com;
https://www.hplfmedia.com;
https://www.globalbmg.com

Textile-based lithium battery shows promise for wearable electronics



Professor Zheng Zijian of Hong Kong Polytechnic University's Institute of Textiles and Clothing displays his team's flexible textile-based lithium battery.

A highly flexible, textile-based lithium battery with a high capacity for storing energy has been developed by researchers in Hong Kong, China.

The team from the Institute of Textiles and Clothing (ITC) at Hong Kong Polytechnic University (PolyU) claims its battery has a volumetric energy density of up to 450 $W.h.l^{-1}$.

At the same time, the bending radius of the battery is as little as 1 mm and it can be folded more than 1000 times while demonstrating only a marginal degradation in its capacity. For comparison, existing lithium batteries that are said to be flexible have bending radii of about 25 mm and maximum capacities of 200 $W.h.l^{-1}$.

In addition, the team says its textile-based battery is lightweight, less than 0.5 mm in thickness, can be charged/discharged rapidly (0.2–1 C) and has a long useful life; the battery's capacity is greater than 80% of its original value after 500 charge/discharge cycles.

Fabrication is based on PolyU's patented technology for polymer-assisted metal deposition (PAMD), which allows the researchers to deposit conductive metals – copper (Cu) and nickel (Ni) – uniformly onto pre-treated yarns. Using PAMD, the researchers can control the deposition time, thickness and sheet-resistance of the coated textiles. The yarns are then woven to make the fabric.

Such metallized fabrics have low sheet-resistances and large specific surface areas; the coated yarns present a much greater useable surface area compared with a two-dimensional (2D) metal foil of the same dimensions.

The researchers then coat the metallized fabrics with lithium for the anodes and other materials for the cathodes, before assembling the fabrics, together with separators and electrolytes, to make the batteries in the form of pouch cells.

Laboratory tests conducted by the ITC team have shown the battery to be extremely mechanically stable, durable and safe, even when deformed. When it was repeatedly folded in half, twisted at different angles or freely crumpled, for instance, its voltage remained unchanged.

Safety tests included subjecting the battery to continuous hammering, trimming with scissors and penetration with nails, and concluded the battery can stably provide power output with no risk of catching fire or breaking.

By supplying energy stably, durably and safely for wearable electronics, the battery has potential applications in such as healthcare monitors, intelligent textiles, smartphones and global positioning system (GPS) trackers.

"Wearable technology has been named as the next big global market opportunity after smartphones and revenues for wearable devices are forecast to grow to US$100 billion by 2024[(1)]," said Professor Zheng Zijian, who leads the ITC research team, adding that all wearable electronics require an energy supply. He also said that the fabrication process for the batteries is compatible with roll-to-roll textile and conventional battery production technologies.

The battery claimed three prizes at the *47th International Exhibition of Inventions of Geneva*, held in Geneva, Switzerland, on 10–14 April 2019—a Gold Medal and two Special Merit Awards, and the team has published its findings with lithium–sulfur batteries in *Nature Communications*. Further, a video describing the work is available on the Internet.

See also: [(1)]*Wearable Technology 2018–2028: Markets, Players, Forecasts*, published by IDTechEx. https://www.idtechex.com/en/research-report/wearable-technology-2018-2028-markets-players-forecasts/606

Nature Communications, 2018, 9(1), *Flexible and stable high-energy lithium-sulfur full batteries with only 100% oversized lithium*, Jian Chang et al. Article number: 4480 (2018). https://www.nature.com/articles/s41467-018-06879-7

https://youtu.be/oGRW9SKmay8

Professor Zijian Zheng, Hong Kong Polytechnic University's Institute of Textiles.
Tel: +852 2766-6441.
Email: zijian.zheng@polyu.edu.hk

Denise Wong, Communications and Public Affairs Office, Hong Kong Polytechnic University.
Tel: +852 3400-2131.
Email: denise.wf.wong@polyu.edu.hk;
http://www.polyu.edu.hk

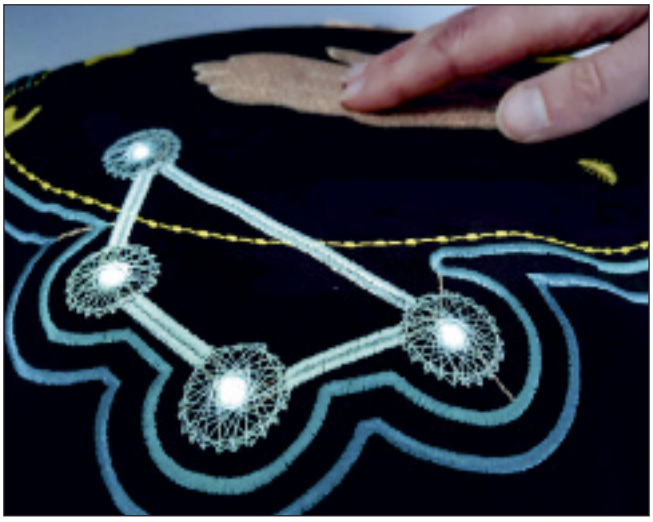
Smart textile series production first shown at *Techtextil/Texprocess*

The series manufacture of smart textile products was demonstrated during the *Techtextil/Texprocess* exhibition, held in Frankfurt, Germany, on 14–17 May 2019, where a microfactory could be seen making cushions equipped with wireless communication capabilities, and sensors and light-emitting diodes (LED) on their surfaces.

"Serial production is no longer a dream of the future, thanks to the latest machine technology, automation and digitization", said Dr Volker Lutz. The researcher from the Institute for Technical Textiles (ITA) at RWTH Aachen University, Germany, said that the microfactory successfully demonstrated the feasibility of serially manufacturing commercially viable smart textile products. He added that, for the smart textiles market to realize its full potential (with some observers predicting it will grow by €2 billion over the next decade), manufacturing must move from manual to serial production.

Coordinated by the ITA, the Smart Textiles Micro Factory involved a number of German partners and demonstrated the smart cushion moving through every stage of its manufacture, from the initial design – via cutting, embroidery and sewing – to the finished product.

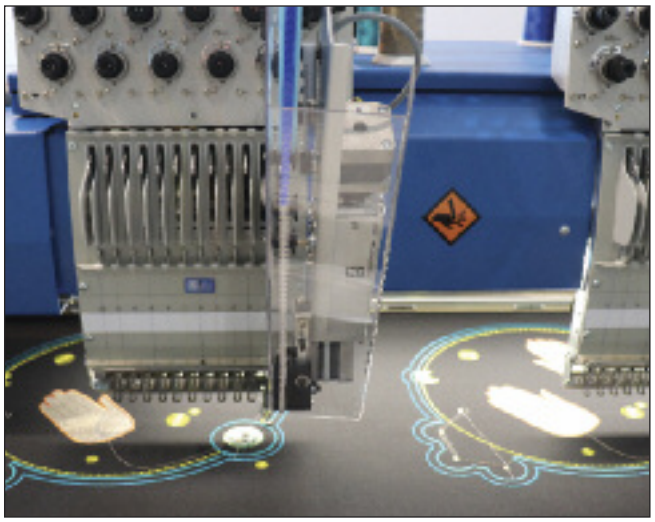
Wear It GmbH of Berlin, designed the product, which is based on the concept of two people being able to communicate with one another via the Internet using the cushion's lights and sensors. ASYS of Dornstadt, Germany, developed the software. The cushion's electronic circuits are based on highly conductive embroidery threads from Madeira Garnfabrik of Freiburg im Breisgau and conductive fabrics from Bremen-based Statex Produktions- und Vertriebs GmbH. Gebrüder Aurich GmbH from Radevormwald supplied the substrate fabrics.



The Smart Textiles Micro Factory's finished product, a cushion equipped with wireless communication capabilities, and sensors and light-emitting diodes on its surfaces.

To embroider the conductive circuits, as well as attaching pads and the LEDs, a Racer 6 SW unit from ZSK Technical Embroidery Systems of Krefeld was used. During the demonstration, the system's six heads were able to make six products at a time while running at a speed of 1000 stitches a minute.

The embroidered fabrics were cut automatically using Ismaning-based Gerber Technology GmbH's X1 unit, which is designed to meet the demands of single- and low-ply flexible materials, including technical textiles and composite reinforcements. Equipped with a pattern-matching system (AutoMatch), the X1 can automatically align patterns such as stripes and checks across cut parts. Further, the system uses vision technology and computer algorithms to make adjustments to bows, skews and repeat variations in the process, and can improve throughput by up to 75% compared with conventional arrangements, according to Gerber.



Working with highly conductive embroidery threads from Madeira Garnfabrik and conductive fabrics from Statex Produktions- und Vertriebs GmbH, the Racer 6 SW created conductive circuits on the fabrics, as well as attaching pads and light-emitting diodes.

The faces of the cushions were sewn together using the 5214 model supplied by Vetron Typical Europe of Kaiserslauten, which has a head capable of turning through 360°. The rotation of the head helps to maintain the required seam pattern along the whole of the sewing path. The manufacturer also says the unit's XB7L robot loads and unloads the fabrics automatically. Further, the robot is equipped with VarioGrip technology, which recognizes the material being processed and so allows dense and porous materials to be guided without the need for manual adjustment of the gripper.

RWTH Aachen University's partner, the Korea Institute of Industrial Technology (KITECH) of Cheonan, was also involved in the development of the electronics.

The ITA says it will continue to work with industrial and research partners to develop the Smart Textiles Micro Factory under a programme called GeniusTex, which will be supported by the German Government's Federal Ministry of Economic Affairs and Energy.

Dr Volker Lutz, Institute for Technical Textiles (ITA) at RWTH Aachen University.
Tel: +49 (241) 80234-21.
Email: Volker.lutz@ita.rwth-aachen.de;
http://www.ita.rwth-aachen.de

Braided carbon composite spaceframe for lightweight railway carriages

The prototype carbon fibre-reinforced thermoplastic spaceframe for passenger rail carriages comprises a series of braided tubes that can be fitted together easily using adhesives and welding.

A recyclable and lightweight carbon fibre-reinforced thermoplastic (CFRTP) spaceframe for passenger rail carriages has been developed in the UK.

Produced as part of the *Very Light Rail (VLR)* project, the prototype spaceframe comprises a series of braided tubes that can be fitted together easily using adhesives and welding. It has been designed by researchers at WMG at the University of Warwick in Coventry in partnership with braiding specialist Far-UK of Nottingham and Stratford upon Avon-based Transport Design International.

The low mass of the prototype would allow electric self-propelled railway carriages of the sort used for short journeys in urban areas to carry more passengers, while reducing the amount of energy needed to propel the vehicle. The design would also reduce the amount of stress the vehicle places on its rails and on road surfaces to which they are fitted.

According to the partners, the other benefits of their spaceframe are numerous. Although each beam used to build the demonstrator appears the same externally, the wall thickness of each varies depending on where on the chassis it will be placed, in order to meet the specific performance needs of that particular section of the frame. As well as keeping tooling costs low, this means that all of the joins can be standardized. If any one of the beams is damaged through, for instance, an accidental impact, it can simply be removed and replaced with a new one. Further, the use of a thermoplastic matrix enables the beams to be recycled easily at the end of their service life.

The braiding process used to produce the beams is highly automated, able to produce over 1.6 km of tubing a day, and they can be moulded in cycle times of under 5 min.

The process is compatible with a wide range of materials. Further to carbon, aramid or glass fibres could be used, while the matrix could be a low-cost polypropylene (PP) or a high-performance polyetheretherketone (PEEK), depending on the demands of the application.

Darren Hughes, Associate Professor, WMG at the University of Warwick.
Tel: +44 (2476) 151255.
Email: D.Hughes@warwick.ac.uk;
https://warwick.ac.uk/fac/sci/wmg;
http://www.verylightrail.com

Lyndon Sanders, Managing Director, Far-UK.
Tel: +44 (1159) 814464.
Email: office@far-uk.com;
http://www.far-uk.com

Start-up has lofty ambitions for composites production process

Additive manufacturing (AM) start start-up Arris Composites has secured US$10 million in funding to develop a process that it says will "address the scalability problem of AM and the steep costs and limitations of composite manufacturing".

Operating in relative secrecy for the past two years, the process developed by the company of Berkeley, California, USA, is designed for the production of continuous carbon fibre-reinforced plastics for the aerospace, automotive and consumer product industries.

The funding of the company was led by New Enterprise Associates (NEA), a venture capital firm with over US$20 billion in assets under management. Former GE Chief Executive Officer (CEO) and Chairman and venture partner at NEA, Jeff Immelt says: "I'm extremely excited about what Arris is building."

Information about the technology being developed by Arris Composites is both sparse and vague, but a Patent awarded to Co-founder of the company, Ethan Escowitz, refers to it as aligned fibre-reinforced moulding.

The technology appears to have made an impression on Immelt, who says: "What we did in automotive to replace non-structural metal with low-cost and lightweight injection-moulded composites in the 1980s, Arris has now enabled for the rest of the vehicle."

Escowitz previously worked as Director of Additive Manufacturing Services at another composites-focused AM company, Arevo of Milpitas, California, USA. The other Co-founders of Arris are Riley Reese and Erick Davidson.

See also: US Patent 2018/0345605, *Aligned fiber reinforced molding*; Assignee: Arris Ciomposites LLC; Inventor: Ethan Escowitz.

Ethan Escowitz, Co-founder, Arris Composites.
Tel: +1 (510) 730-0067.
https://www.linkedin.com/in/ethane;
https://arriscomposites.com

Closed-loop recycling of carbon composites for the marine industry

ELG Carbon Fibre is working with sailing team INEOS Team UK to ensure sustainable materials and practices are incorporated into its build programme for the *2021 America's Cup*.

ELG of Coseley has been supplier to INEOS Team UK of Portsmouth since the campaign began in 2018 and has processed 1000 kg of its carbon fibre manufacturing waste and end-of-use parts.

These are converted into milled and chopped products to make thermoset and thermoplastic compounds and nonwoven mats, which have then used to manufacture composite parts for INEOS Team's AC75 boat that will compete in Auckland, New Zealand, in 2021. The AC75 Boat 1 will be launched this summer.

Although precise details of the boat's design remain confidential, ELG says that its nonwovens have been used in the production of two cradles that support the AC75 during transit, and in the moulds for its hull and deck.

ELG's technicians conducted a range of fibre characterisation analyses on INEOS Team UK's feedstock. Every batch of material that is processed is also given a classification to ensure the traceability and consistency of the fibres recovered, and therefore the final product. All these processes adhered to BS EN ISO 9001:2015 and EN 9100:2016 quality management standards.

Both organisations view this partnership as a means to raise awareness of the urgent need for closed-loop recycling practices within the marine industry.

Naval Architect for INEOS Team UK, Alan Boot, says: "We are diverting waste away from landfill and closing the loop in our production methods wherever possible. ELG's products have fitted seamlessly into our manufacturing processes, which demonstrates how successfully these materials can be in a range of commercial markets."

The recycling of carbon fibre-reinforced plastics (CFRPs) will be a topic of discussion at the first edition of *Textile Opportunities in a Changing Automotive Industry*, which will take place in Birmingham, UK, on 5–6 February 2020 (see also, outside back cover).

Frazer Barnes, Managing Director, ELG Carbon Fibre Ltd.
Tel: +44 (1902) 406010.

INEOS Team UK's Test Boat T5 is a foiling monohull modified to match the fundamental parameters of the AC75, the construction of which involves the use of recycled carbon fibres.

Email: frazer.barnes@elgcf.com;
http://www.elgcf.com

Dan Wilkinson, Communications and Digital Manager, INEOS Team UK.
Tel: +44 (7) 7862-23444.
Email: dan.wilkinson@ineosteamuk.com;
http://www.ineosteamuk.com

Jill Gwinnutt, Marketing Manager, Textile Opportunities in a Changing Automotive Industry.
Tel: +44 (0)870 1657210.
Email: jill.gwinnutt@intnews.com;
http://www.technical-textiles.online/TOAI

Manufacturer of high-performance carbon fibre reinforcement secures backing

A developer and manufacturer of a novel three-dimensional (3D) carbon fibre reinforcement for the production of impact-resistant and durable composites has this year raised US$1.75 million in funding.

Boston Materials of Bedford, Massachusetts, USA, says that in comparison with conventional carbon fibre-reinforced plastics (CFRPs), its Carbon Supercomposites demonstrate a 500% increase in their z-axis (through-thickness) strength and a 150% increase in their interlaminar shear strength.

These mechanical properties are imparted by coating a standard carbon fibre fabric with milled carbon fibres, which are then aligned vertically. The milled fibres effectively distribute the multiaxial loads throughout the composite, which – according to Boston Materials – increases toughness by 300% and strength by 35% when compared with standard CFRPs, without any detriment to its stiffness.

Further, the company claims that a component made from Carbon Super-composite will deform noticeably before there is a significant reduction in its strength or fracture-toughness, meaning that an end user will be able to detect a change in the apparent stiffness of the component made from it prior to catastrophic failure.

The use of the milled fibres is also said to increase the through-thickness thermal conductivity of CFRP by 300%, enabling polyacrylonitrile (PAN)-based carbon fibre composites to match the conductivity of costly pitch-based alternatives.

The material could find use in a wide variety of industries, potential that has enabled Boston Materials to raise US$1.75 million in initial funding from Clean Energy Ventures of Boston, Massachusetts, SABIC Ventures of Riyadh, Saudi Arabia, and members of the Clean Energy Venture Group. With the funding, which was secured in March 2019, the company has secured a pilot production facility and manufacturing equipment, and will add to its management and engineering team.

Vice President of Technology and Innovation at SABIC, Fahad Al-Sherehy, says: "There is an opportunity for Boston Materials' Carbon Supercomposite technology to quickly be integrated with SABIC's thermoplastics portfolio."

Anvesh Gurijala, Chief Executive Officer, Boston Materials.
Tel: +1 (978) 844-7636.
Email: ag@bomaterials.com;
https://bostonmaterials.co

Glass fibre-reinforced thermoplastic seat shell is developed for Audi

Glass fibre-reinforced polyamide (PA) 6s from Lanxess are being used in the high-volume manufacture of lightweight shells for the electronically adjustable rear seats in Audi's A8 sedan.

The shells are manufactured using a hybrid moulding process by Faurecia Automotive Seating of Stadthagen, Germany, from a continuous glass fibre-reinforced PA 6 (Tepex dynalite 102 RG600(2)/47%), which is overmoulded with a short glass fibre-reinforced PA (Durethan BKV30H2.0).

Henrik Plaggenborg is Head of Tepex Automotive at Lanxess' High Performance Materials (HPM) business unit in Cologne, Germany. He says that, owing to the use of glass fibre-reinforced PAs, the shells are around 45% lighter than a comparable metal design. Further, several functions can be integrated into one part, reducing component-count in comparison with metal alternatives, makes the use of composites cost-effective. The shell can also withstand the high mechanical loads experienced in a crash.

Manufacturing conventional metal shells is time-consuming as they consist of numerous individual parts that have to be joined together using multi-step welding processes. A Project Manager at the Tepex Automotive group of HPM, Tilmann Sontag, says: "In the hybrid moulding process, by contrast, a ready-to-install component is created in a single process step. The pre-contoured and heated semi-finished composite product [Tepex dynalite] is formed directly in the injection-moulding tool for this purpose, and equipped with numerous functions by means of injection moulding. This simplifies subsequent assembly and leads to considerable savings in production costs."

The Audi A8 can be fitted with two electronically adjustable individual rear seats, the composite shells of which have been developed by Faurecia Automotive Seating

In addition to reinforced ribs, a piping groove for securing the seat cover in place as well as numerous holders and guides (such as for seat ventilation and cable holders) are integrated into the component. The clips to attach the seat shell are also directly injected. "The shell can be assembled easily and quickly without screws using the clips, and disassembled again for servicing purposes. The clips are highly stable and meet all relevant safety requirements," continues Sontag.

Lanxess supported the development of the seat shells and the complete rear-seat system with its HiAnt simulation package. For example, HPM supplied the material data required by Faurecia in order to carry out structural simulations. In addition, several strategies for forming the semi-finished composite product precisely and reproducibly were analysed using draping simulation tools. The findings were incorporated into recommendations for designing the tools and processes. "For example, we recommended special clamping elements to secure the plasticized composite insert in the injection-moulding tool," recalls Sontag.

Tepex is developed and produced by Lanxess subsidiary Bond-Laminates GmbH of Brilon, Germany, and is used to produce front ends, brake pedals, underbody panelling components, reinforcing structural inserts for body detachable parts, and carriers for door and electronic modules.

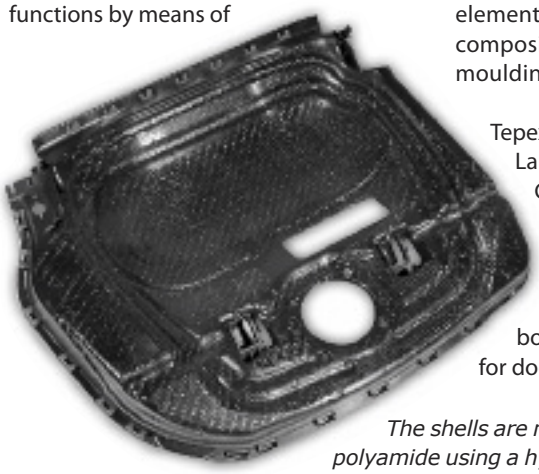
Lanxess believes that the composite could be used to manufacture backrests and armrests, as well as seat shells, for the complex seat systems likely required for autonomous vehicles.

Plaggenborg says: "We are thinking, for example, of freely swivelling or removable seats that not only weigh little, but also meet all crash requirements and are fitted with numerous integrated functions such as seat belts, and infotainment and comfort systems."

The place of composites in the automotive industry's future will be a topic of discussion at the first edition of *Textile Opportunities in a Changing Automotive Industry*, which will take place in Birmingham, UK, on 5–6 February 2020 (see also, outside back cover).

Michael Fahrig, Spokesperson Trade and Technical Press, Lanxess.
Tel: +49 (221) 8885-5041.
Fax: +49 (221) 8885-4865.
Email: michael.fahrig@lanxess.com;
http://lanxess.com

Jill Gwinnutt, Marketing Manager, Textile Opportunities in a Changing Automotive Industry.
Tel: +44 (0)870 1657210.
Email: jill.gwinnutt@intnews.com;
http://www.technical-textiles.online/TOAI



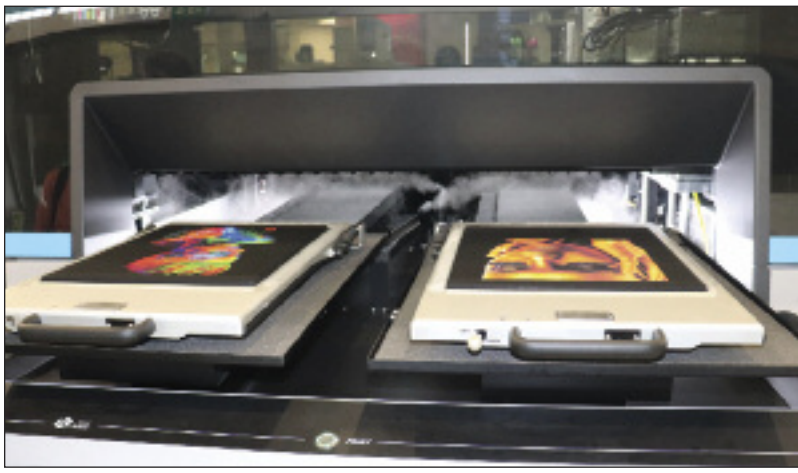
The shells are manufactured by Faurecia Automotive Seating from glass fibre-reinforced polyamide using a hybrid moulding process.

Digital innovation stimulates good business for print machinery

Exhibitors of digital printing technology at the latest *ITMA* (which was held in Barcelona, Spain, on 20–26 June 2019) did brisk business and showed plenty of innovations, according to Adrian Wilson.

The global value of the market for digitally printed textiles was worth €2.83 billion in 2018 (generated by 2.17 billion square metres of fabric), according to *The Future of Digital Textile Printing to 2023*[1], the latest report from Smithers-Pira of Leatherhead, UK. Further, by 2023 the market value will reach €4.9 billion, representing a compound annual growth rate (CAGR) of 11.6%. The rate is down from the 16% enjoyed in the period 2013–2017, but is no cause for alarm; such falls are merely symptomatic of any nascent, high-growth market.

The buoyancy of the market was further underlined by the high level of representation of digital-printer manufacturers among the 1717 exhibitors at *ITMA* in Barcelona, Spain, on 20–26 June 2019[2].



Kornit's latest development, a direct-to-garment printing platform (Atlas), was demonstrated during ITMA (see also, page 17).

HP's *ITMA* debut

A notable development at *ITMA* in 2019 was the debut as an exhibitor of HP Inc (formerly Hewlett-Packard) of Palo Alto, California, USA (see also, page 18 and page 9). The information technology (IT) specialist, with extensive experience of developing, manufacturing and selling computer printers, was at the show to underline its strategy of moving into the textile market with its Stitch S Series portfolio of wide-format printers.

HP has also identified textile printing as a fast-growing market, which it valued in 2018 at US$3.6 billion. The company's higher valuation compared with that of Smithers-Pira 'sforecast is justified by its definition of the market, which it widens to include such as event banners, customized wallcoverings and pillows[3]. According to HP's definition, the market will grow to US$5.5 billion by 2025.

The company says its Stitch S Series portfolio is based on dye sublimation printing on polyester (PES) and PES blends, and aims to improve the colour accuracy of the process, and lower the lead-times and costs for print providers.

HP also stresses the benefit to the environment of digital print production. By making short-run production commercially viable and offering effective manufacturing-on-demand, digital printing can help cut the pollution generated by manufacturing and its consumption of water, as well as reduce the amount of unused clothing/fabric that ends up in landfills.

Global General Manager of Large Format Graphics at HP Barcelona, Joan Pérez Pericot said dye sublimation has already revolutionized production, especially for designs that require multiple colours, repeat patterns and photographic-quality images. He added that many garment brands rank sustainable production highly in their strategies.

More signs of HP's commitment

As further evidence of its strategy, during *ITMA* 2019 HP announced the acquisition of OneFlow Systems, a leading provider of cloud-based software for print workflows, which is based in London, UK. The acquisition, which closed on the 10 July 2019, had previously been an important partner, working closely with HP to co-develop a suite of simple-to-use software programmes, such as HP PrintOS Site Flow, and application programming interfaces (APIs), designed to simplify online print ordering and to help

commercial printers manage thousands of short-run, personalized jobs, from submission to shipment.

EFI Reggiani

The biggest investment announced during *ITMA* concerned a comprehensive modernization programme for Egypt's textile industry[4] (see also, *Modernizing Egypt's textile industry*, page 18), which will involve deliveries of equipment from the show's exhibitors with a total value of around €1 billion. As part of this programme, EFI Reggiani of Fremont, California, USA, will supply its new single-pass inkjet printer (Bolt), which also won other orders, including two from Pakistani companies—the weaver, Zaman of Hyderabad, and Lahore-based printer Hunbul. Moreover, the first installation, at Texprint srl of Prato, Italy, is already in full production.

Printing at a resolution of 600 × 600 dots per inch (dpi), a Bolt printer can run at 90 m.min^{-1} and is intended for

Brands seek sustainable production

Several of the speakers at the *European Digital Textile Conference*, which was held on 24 June 2019 as part of *ITMA*, spoke about the high importance that customers (major clothing brands) now place on the sustainable production of garments.

HP's Global Textile Brands Strategist Carlos Lahoz, for instance, said that digital processing makes short-run production and manufacturing-to-order feasible—factors that bigger brands – such as Hennes & Mauritz (H&M) of Stockhom, Sweden – could begin to exploit to respond rapidly to what is and is not selling in their stores, so reducing unsold inventory. "Last year H&M had to announce it had a US$4.3-billion inventory of unsold clothes", he told the conference.

Meanwhile, Lewis Shuler from Under Armour told the conference that the performance-wear brand has been pursuing its *Digital First* strategy for two years. As a result, the company from Baltimore, Maryland, USA, has seen the proportion of its inventory for decorated fabrics processed on digital sublimation printers grow from 5% to 90%.

Pictured at the ITMA 2019 European Digital Textile Conference (left to right) are: Carlos Lahoz, HP's Global Textile Brands Strategist; Lewis Shuler of Under Armour Print and Material Innovation; Bart Sights, Senior Director Technical Innovation for Levi's.

Shuler cited the key reasons for this transition as being:

- making production more environmentally sustainable;
- reducing and better managing inventories;
- reducing lead times;
- improving the reproducibility of designs;
- improving colours.

He added that the company feels its longer-term prospects will be enhanced by making the switch now, but that even its well-established partners and its own staff needed considerable persuasion before adopting the changes.

Currently, it is using transfer printing, but Under Armour already has plans to move to direct-to-fabric digital production.

Bart Sights of Levi Strauss said that the company is not digitally printing its denim jeans, but it is digitally finishing them with laser treatments as part of a programme called *FLX*, which was initiated to eliminate the need to use a certain unspecified chemical.

Under the programme, Sights added, the company, which has its headquarters in San Francisco, California, USA, realized it would then benefit further from making changes throughout processing back to the design stage.

Levi's jeans are now produced by its suppliers in standard light, medium and dark shades, and shipped to the brand's own distribution centres, where their final design and finishing is carried out in response to market needs.

Later in 2019, the brand plans to launch the Levi.Com website, which will allow consumers to personalize the finish of their own garments. After that, it plans to introduce options for in-store personalization.

continuous operation. Its recirculation printhead is designed to require minimal maintenance and to start-up quickly, reducing the costs of printed textile printheads and allowing users to create a broad range of designs quickly and efficiently. The printer can also include one or more rotary printing stations for the application of special effects.

EFI Reggiani has also been doing a lot of work on sustainable processing. The company's pigment printing process (Terra), for instance, eliminates the need for steaming, washing and stentering, cutting the workflow down to just preparation, printing and inline polymerization. Similarly, its latest direct sublimation process for transfer-printing on PES and PES/elastane fabrics uses inline fixation to eliminate the need for steaming and washing. Consequently, both processes save time and money for the manufacturers.

Finally, EFI Reggiani also introduced a suite of software (Fiery DesignPro) written to help streamline the production of repeat orders and ensure consistent colours for wovens and knits, wherever and however they are produced, from design to manufacture.

Kornit

Kornit (see also, page 15) also announced new sales during the Barcelona show: two Avalanche Poly Pro systems to Westbury, UK-based T Shirt & Sons; one Avalanche Poly Pro to Sydney-based Garment Printing Australia. Co-Founder of T Shirt & Sons Andy Lunt said: "We are seeing a strong and increasing demand for retail-grade prints on PES, but so far producing them on an industrial scale has proved a challenge. "The Avalanche Poly Pro is not just an evolution, but is having a disruptive impact on this entire market segment."

Kornit, which has its headquarters in Rosh-Ha'Ayin, Israel, already boasts the high-profile online retailer Amazon of Seattle, Washington, USA, as one of its customers[5]. Further, Amazon not only purchased a large number of Kornit on-demand textile production systems, but also demonstrated its belief in the technology by launching a scheme to purchase around US$38 million of Kornit's shares over a five-year period beginning in 2017.

Following the success of its Storm HD6 and Avalanche Poly Pro models, in 2019 Kornit launched the direct-to-garment printing platform (Atlas)[5]. The heavy-duty Atlas has been developed for industrial garment decoration and is designed to deliver a typical annual capacity of up to 350 000 impressions. As such, sales are targeted at high-production garment decorators, as well as medium-to-large screen printers and businesses looking to combine their use of the latest technology with a low cost of ownership.

A Mimaki Tiger-1800B MkII on the ITMA showfloor (see also, page 18).

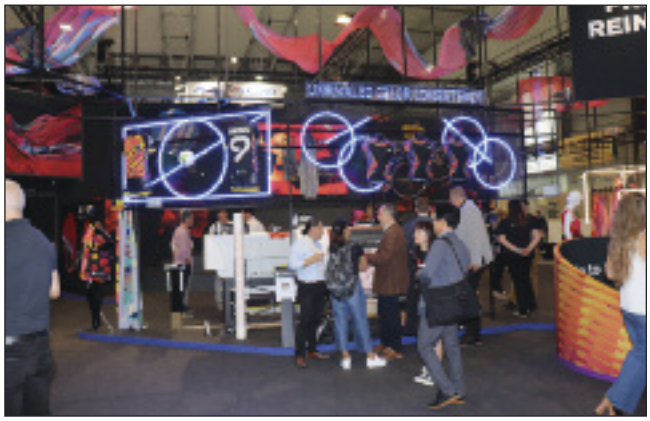
The Atlas is equipped with new recirculating printheads and a newly developed ink (NeoPigment Eco-Rapid). Its print engine is complemented by raster image processing (RIP) software and produces prints to meet the high standards of quality and durability demanded by retailers.

Atlas is able to operate with Kornit's Internet-based business intelligence, productivity analytics and optimization software (Kornit Konnect), which is designed to make network connectivity easy, to support fleet management, and to optimize multiple systems across multiple sites around the world.

SPG prints

In Barcelona, SPGPrints of Boxmeer, The Netherlands, announced the sale of a Javelin multi-pass printer to the Polish company Teofilów of Lodz, as well as a bestLEN 7412 direct laser engraving machine to the knitted-fabric maker Windsor of Naucalpan, Mexico.

On the stand, SPGPrints gave demonstrations of the second generation of its single-pass printer (Pike) applying reactive ink to a viscose fabric. The original Pike made a dramatic impression when it was introduced during the previous *ITMA* (held in Milan, Italy,



HP (see also, page 15) became a first-time exhibitor at ITMA, underlining its strategy to enter the printed-textiles market and demonstrating its portfolio of wide-format printers (Stitch S Series).

on 12–19 November 2015)[6]. The latest version has been enhanced in order to achieve even higher speeds, and it offers the highest resolution (1200 dpi), uses the smallest droplets and has the lowest consumption of ink available on the market, the manufacturer claims.

MS Printing Solutions

MS Printing Solutions announced the sale of ten printers, including three of its scanning systems (MS Mini Lario) and three single-pass machines (LaRio), to customers in Bangladesh, Italy, Spain and Turkey.

With its 64 printheads, the Mini Lario can reach a maximum printing speed of 1094 $m.h^{-1}$, said the company from Caronno Pertusella, Italy. Meanwhile the latest version of the LaRio, first launched at *ITMA* in 2011 (held in Barcelona, Spain, on 22–29 September), now features in-line fabric pre-treatment, which increases throughput considerably.

Mimaki

Nagano, Japan-based Mimaki showcased a new hybrid digital textile printer, which it claimed is uniquely able to offer direct-to-textile and transfer printing. In addition, multiple sets of inks can be loaded simultaneously to allow printing on a range of fabrics.

A Mimaki Tiger-1800B MkII (see also, page 17) was also exhibited operating in its dye-sublimation configuration. This can produce extremely high-quality products (as high as 1200 × 1200 dpi resolution) while running at speeds of up to 385 $m^2.h^{-1}$, visitors were told.

Mimaki further demonstrated its software (TA Job Controller), which it has developed for textile production on the company's Tiger Pro and Rimslow TR printers. The software allows users to connect one-on-one to the RIP system and other devices to create an automated workflow from design to post-print processes.

Modernizing Egypt's textile industry

The biggest announcement concerning investment during *ITMA* was that of a comprehensive modernization programme for Egypt's textile industry, which will involve deliveries of equipment valued at around €1 billion from exhibitors.

The programme includes orders for:

- around 780 000 new spindles supplied by Rieter, of Winterthur, Switzerland (see also, page 8), Savio, of Pordenone, Italy, and Marzoli of Palazzolo sull'Oglio, Italy.
- 1250 weaving looms from Itema of Colzate, Italy;
- knitting machinery from Karl Mayer of Obertshausen, Germany;
- finishing machinery from Benninger of Uzwil, Switzerland, Leonberg, Germany-based Brückner and Thies from Coesfeld, Germany.

References

[1]https://www.smitherspira.com/industry-market-reports/printing/digital-textile-printing-to-2023

[2]*Technical Textiles International*, June 2019, *Innovations in digital printing continue at a rapid pace*, page 35; https://www.technical-textiles.net/node/74900

[3]*Technical Textiles International*, April 2018, *Digital printing technology moves into high-volume markets*, page 35; https://www.technical-textiles.net/node/74030

[4]https://www.technical-textiles.net/node/74944

[5]*Technical Textiles International*, May 2019, *Digital printing continues to drive innovation among manufacturers*, page 55; https://www.technical-textiles.net/node/74808

[6]*Technical Textiles International*, November 2015, *ITMA welcomes the dawn of the age of digital textile printing*, page 27; https://www.technical-textiles.net/node/71820

Further Mimaki exhibits were:

- Mimaki TS55-1800—a dye-sublimation printer targeting users new to the market, as well as those with limited experience;
- Mimaki UCJV300-160—a roll-to-roll integrated inkjet printer/cutter capable of four-layer printing.

Epson offers 16-colour palette

Finally, Epson introduced the Monna Lisa Evo Tre 32, a digital printer offering 16 colours, which allows it to print with a palette close to that achievable with traditional rotary printers, according to the manufacturer of Suwa, Japan. In addition, Monna Lisa Evo Tre 32 has a resolution of 1200 dpi, an ink capacity of three litres and 32 Epson PrecisionCore printheads.

Further information

Smithers Pira; https://www.smitherspira.com

Paula Camarasu, Large Format Production Marketing Manager for Europe, Middle East and Africa, HP Graphics Solutions Business.
Tel +34 (647) 781138.
Email: paula.camarasu@hp.com; http://www.hp.com

David Lindsay, Public Relations Manager, EFI Regianni.
Tel +1 (404) 931-7760.
Email: david.lindsay@efi.com; http://www.efi.com

Zaman Textile Mills.
Tel: +92 (21) 35123731.
http://www.Zamantextile.com

Hunbul Textiles.
Tel: +92 (42) 35260601-5.
Email: info@hunbultex.com; http://www.hunbultex.com

Oliver Luedtke, Head of Global Public Relations, Kornit.
Tel: +49 (211) 200-55-200.
Email: oliver.luedtke@kornit.com; http://www.kornit.com

Andy Lunt or Jon Lunt, T Shirt & Sons.
Tel: +44 (1373) 301645.
Email: sales@tshirtandsons.co.uk;
http://www.tshirtandsons.co.uk

Garment Printing Australia.
Tel: +61 (402) 054-086.
Email: nayyar@garmentprinting.com.au;
http://garmentprinting.com.au

Maike Kanters, Press & Communications, SPGPrints BV.
Tel: +31 (485) 599296.
Email: maike.kanters@spgprints.com;
https://www.spgprints.com

Teofilów.
Tel: + 48 (785) 998-803.
Email: knit@teofilow.com.pl;
http://www.teofilow.com.pl

Windsor.
Tel: +52 (5300) 0600.
Email: contacto@tywindsor.com;
http://www.tywindsor.com

Luigi Milini, President, MS Printing Solutions.
Tel: +39 (2) 9650169.
Email: info@msitaly.com; http://www.msitaly.com

Bert Benckhuysen, Senior Product Manager, Europe, Middle East and Africa, Mimaki.
Tel: +31 (63) 169-8940.
Email: b.benckhuysen@mimakieurope.com

Ivan Lesmana, Public Relations, Mimaki Europe.
Tel: +31 (20) 462-7640. Fax: +31 (20) 462-7649.
Email: i.lesmana@mimakieurope.com;
http://www.mimakieurope.com

Silvia Carena, Public Relations Manager, Epson Italia SpA.
Tel: +39 (02) 660321. Fax: +39 (02) 612-3622.
Email: silvia_carena@epson.it; http://www.epson.it

Levi Strauss; https://www.levisstrauss.com

Under Armour; https://www.underarmour.com

Rieter; http://www.rieter.com

Savio Macchine Tessil; http://www.saviospa.com

Marzoli; http://www.marzoli.com

Itema SpA; http://www.itemagroup.com

Karl Mayer Textilmaschinenfabrik GmbH;
http://www.karlmayer.com

Benninger AG; http://www.benningergroup.com

Brückner Textile Technologies GmbH & Co KG;
https://www.brueckner-textile.com

Thies GmbH; http://ThiesTextilmaschinen.de

Outdoor Retailer continues to hold the torch for sustainability

The outdoor industry is the vanguard for sustainable manufacturing practices in the textile and apparel sector, according to John McCurry who attended the *Outdoor Retailer Summer Market* show in Denver, Colorado, USA to learn more.

Sustainability continues to be the big theme at trade shows for textiles and performance apparel, and this year's *Outdoor Retailer Summer Market* (held on 18–20 June 2019, in Denver, Colorado, USA) was no exception. Exhibits focused on products with recycled content, garments that offered durability and products made using environmentally sound processes. Further indications at the show of the industry's attitude to these issues were provided by:

- the distribution of thousands of re-usable hard-plastic bottles to discourage the use of their single-use counterparts;
- an education programme encouraging the reduction of the overall use of plastics organized by 4Ocean of Boca Raton, Florida, USA, a company dedicated to the removal of plastic from the oceans.

Objective advice from the Hohenstein Institute

The Hohenstein Institute had one of the smaller stands at the show, but this in no way reflects the breadth of its outdoor-related services. The Bönnigheim, Germany-based organization, which has its US headquarters in Ligonier, Indiana, came to *Outdoor Retailer* with several objectives, including spreading the word about its recently launched Hohenstein Academy.

Outdoor Retailer Summer Market was held on 18-20 June 2019, in Denver, Colorado, USA.

Senior Technical Director for the Hohenstein Institute of America John Frazier (left) and Jan Beringer (right) from the parent organization the Hohenstein Institute of Bönnigheim, Germany, on the stand at Outdoor Retailer Summer Market.

Senior Technical Director for the Hohenstein Institute of America John Frazier said: "We view the *Outdoor Retailer* show as a great opportunity to connect with the outdoor brands. A lot of them have sustainability and chemistry programmes. There is concern about chemicals and how they show-up in products."

Jan Beringer, Head of Research and Development at Hohenstein's Department for Function and Care, added that the organization aims to help fill an educational void in the textile–apparel supply chain. He believes that knowledge within the textile industry is diminishing and there is a need for training its workers, particularly about sustainability, recycling and working with materials that can be recycled. "This is something we try to address."

Frazier believes the prevalent business model, where apparel brands have contracts with offshore manufacturers to make their products, is a complicating factor. Brands that contract-out their manufacturing assume the supply chain understands all the relevant issues.

Gehring-Tricot Corp and its Tweave Division are regular exhibitors at Outdoor Retailer.

"Microfibres are a big issue right now," Frazier said. "The discharge of hazardous chemicals is a big deal. People want to know what kinds of chemicals are being used on their products." However, as supply chains get bigger, the technical expertise of the brands gets smaller: "I think there is a real need for technical expertise and the ability to communicate that to suppliers and brands."

Hohenstein's Academy was established to address that need. It offers instruction in a variety of areas, including basic textile knowledge, clothing technology and safety, as well as sustainability.

Hohenstein maintains a local presence to serve its brand customers on both US coasts. The organization has grown substantially in recent years and is penetrating the US market, Frazier said, although most of its testing work is still conducted in Germany.

Invista shows the softer side of Cordura fabrics

Cordura[1] a brand of Invista from Wichita, Kansas, USA, which in contrast to the Hohenstein Institute had one of the larger stands at that the show, promoted new application areas for its durable fabric.

Global Business Development Director Cindy McNaull summarized the theme by saying: "We are showing Cordura's softer side. Cordura has traditionally been well-known in bags, packs and luggage, but in recent years, we have come out with a really extensive collection of blends with natural fibres. We have a wide range of knits and knits that are blended with cotton. We have a really strong portfolio of not only mills, but fabrics from those mills that focus on the softer side of durability."

McNaull added that durable products are a bedrock for sustainable manufacturing.

Sustainable zippers from YKK

Zipper manufacturer YKK of Tokyo, Japan, also made sustainability its principal theme for *Outdoor Retailer*.

Senior Product Development Manager John Holliday highlighted the company's existing Natalon range, consisting of products made using recycled polyester (PES) and its waterless dyeing technology (Eco-Dye).

In addition, in June 2019, YKK began sales of its zipper (GreenRise), made using PES based on raw materials derived from plants (sugarcane). The zipper has applications that include jackets, outdoor gear, women's dresses and luggage. Holliday added that YKK's research and development (R&D) department is developing more products based on plant-based raw materials.

The company's North American headquarters are in Marietta, Georgia, USA.

Unifi's focus on *Outdoor Retailer*

Outdoor Retailer is the primary trade show in North America to be attended by Unifi[2] of Greensboro, North Carolina, USA, according to Global Sales and Marketing Manager Jay Hertwig. "Sustainability has been driven by the outdoor market and it's been where we have built our brands," he said. "*Outdoor Retailer* has been a great platform for us to launch new products."

In particular, Unifi promotes its products under the Repreve brand, which consists of high-performance PES yarns made from recycled plastic bottles and recycled polyamide (PA) yarns. Unifi expects to have recycled 20 billion bottles by 2020.

The company's *Repreve Our Ocean* programme, for instance, aims to divert post-consumer bottles that would otherwise likely find their way into the oceans, Hertwig said. This version of Repreve specifically uses bottles collected from coastal regions in areas of the world that do not have recycling infrastructures or programmes.

Finally, Unifi exhibited a new collection of soft, dimensionally stable insulation products intended for cold-weather garments and bedding materials. These were developed in collaboration with DowDuPont Biomaterials of Wilmington, Delaware, USA, and Youngone of Seoul, South Korea.

Youngone, a manufacturer of outdoor and athletic clothing is using DuPont's partially plant-derived polytrimethylene terephthalate (PTT) fibre (Sorona) and Unifi's Repreve fibre in the new products.

Gehring-Tricot's focus on customized fabrics

Gehring-Tricot Corp[3], based in Garden City, New York, USA, is a regular exhibitor at *Outdoor Retailer*, showing its high-performance knitted and woven fabrics, with the emphasis on its diverse capabilities and its development of customized fabrics, rather than on a specific product. The company's Tweave Division, with its line of stretchable woven fabrics, is by far the company's most familiar brand at the show, according to Gehring-Tricot's Vice President of Sales and Marketing Bill Christmann.

Most of the visitors to the stand were in search of lighterweight fabrics and textiles with multiple functionalities, Christmann said.

Wigwam's next-generation sock

Wigwam, a sock manufacturer from Sheboygan, Wisconsin, USA, presented its latest product (SynchroKnit), which will be available to buy from January 2020. The company described the sock as the next generation in performance construction.

Wigwam says the sock has low bulk, and offers more support and more comfort compared with traditional socks. Paige Boucher, who handles public relations for the company, says the sock took about four years to develop and is the subject of the company's third patent in its 114-year history.

Boucher says the construction eliminates the need for some of the stitches from the top of the sock to the ankle. Fewer stitches around the ankle means less bulk in the thinnest area of the wearer's leg and helps to prevent wrinkling inside their shoes.

Cordura Global Business Development Director Cindy McNaull shows a garment made from a fabric that combines fibres of Cordura Naturalle with DowDupont Biomaterials' polytrimethylene terephthalate (Sorona). The result is a soft, lightweight, but hardwearing textile, she said.

References

[1] *Technical Textiles International*, September 2015, *Durability is the core to the success of Invista's Cordura brand*, page 19; https://www.technical-textiles.net/node/71830

[2] *Technical Textiles International*, September 2012, *Unifi takes the lead in the production of recycled polyester*, page 33; https://www.technical-textiles.net/node/462

[3] *Technical Textiles International*, December 2016, *Keeping it in the family—how Gehring-Tricot adapts and thrives*, page 8; https://www.technical-textiles.net/node/73050

Further Information

Jennifer Pelkey, Senior Marketing Director, Emerald Expositions.
Tel: +1 (949) 226-5763.
Email: jennifer.pelkey@outdoorretailer.com;
https://www.outdoorretailer.com/home-summer

Andrew Cooper and Alex Schulze, Co-Founders, 4ocean.
Email: pr@4ocean.com; https://4ocean.com

Ben Mead, Hohenstein Institute America Inc
Tel: +1 (260) 740-2166.
Email: usa@hohenstein.com;
https://www.hohenstein.us

The Hohenstein Institute
Tel: +49 (7143) 271-0. Fax: +49 (7143) 271-51.
Email: info@hohenstein.de;
https://www.hohenstein.com

Cindy McNaull, Cordura Global Business Development Director, Invista.
Tel: +1 (704) 900-8768.
Email: cindy.d.mcnaull@invista.com;
https://www.cordura.com;
https://www.kochind.com/companies/invista;
https://www.invista.com

YKK Corp of America, North and Central America Group.
Tel: +1 (770) 261-6120.
https://ykknorthamerica.com; https://www.ykkeurope.com;
https://www.ykkfastening.com

Sharon Roberts, Investor Relations, Unifi Inc.
Tel: +1 (336) 316-5505.
Email: sqrobert@unifi.com;
https://unifi.com; https://repreve.com

http://biosciences.dupont.com/solutions/biomaterials;
http://sorona.com

https://www.youngonecorporation.com

Bill Christmann, Vice President of Sales and Marketing, Gehring Textiles Inc.
Tel: +1 (516) 747-4555. Fax: +1 (516) 747-8885.
Email: billchristmann@gehringtextiles.com;
http://www.gehringtextiles.com

Wigwam Mills Inc
Tel: +1 (855) 275-0356.
Email: socks@wigwam.com; https://www.wigwam.com

China's carbon fibre industry is now positioned to flourish

Improvements in the technologies employed, increases in capacity, an end to the structural problems that have plagued the industry since its inception and a voracious home market all combine to indicate that China's domestic suppliers of carbon fibre have a very bright future, reports Jason Chen.

China's carbon fibre market has been dominated by foreign suppliers – such as Toray of Tokyo, Japan, Zoltek of St Louis, Missouri, USA, and SGL of Wiesbaden, Germany – since it first opened to the outside world in the 1980s, with domestic manufacturers left to fight over a small share. However, this landscape could change in the near future as Chinese suppliers fix the problems that have haunted them for decades, improve their technologies and increase their capacities to meet the booming domestic demand.

Several factors are contributing to this change:

- the companies have been operating more independently of the State since the mid-2000s, helping to accelerate several important breakthroughs in the past decade;
- the government continues to support state-owned companies, helping them through periods of financial losses;
- the fast-growing manufacturing industries, notably that for sports products, are boosting their consumption of low-end carbon fibres, which are the main products of Chinese carbon fibre suppliers.

Challenges to address

The Chinese Government has guided and supported the country's carbon fibre industry since its emergence in the 1960s, helping the industry survive a long difficult time, but also causing problems that still inhibit the growth of homegrown suppliers today. Professor Xu Jian, Vice Director of the Institute of Chemistry, part of the Beijing-based Chinese Academy of Science, summarizes the two main areas of concern stemming from the government's sponsorship of the industry:

- management issues—research and development (R&D) activities and manufacturing are supported and guided by different government departments. These disparate departments failed to integrate resources to form a full chain from R&D to manufacturing—most of the R&D was undertaken by academic institutes and the findings were not passed on to the manufacturers;

Management and strategy issues arising from the involvement of the government have plagued China's carbon fibre manufacturing industry since its origin, according to Professor Xu Jian (pictured), Vice Director of the Institute of Chemistry, part of the Beijing-based Chinese Academy of Science.

- strategy issues—misguided strategies often resulted in the failure of final products. For many years, for instance, Chinese suppliers focused on carbon fibres, but neglected the raw materials such as precursors; precursors made by Chinese companies often have poor structural regularity, low degrees of crystallization and orientation, and surface defects, which make it hard for them to be converted to produce carbon fibres good enough to compete with those from overseas rivals.

China was in fact one of the earliest countries to engage in carbon fibre manufacturing. It started R&D on carbon fibres in 1962, even while the country was still suffering economic losses owing to the implementation of its *Great Leap Forward* campaign (1958–1962). However, according to Xu: "Little progress was made until carbon fibre was first listed in China's national plan in 1975." In

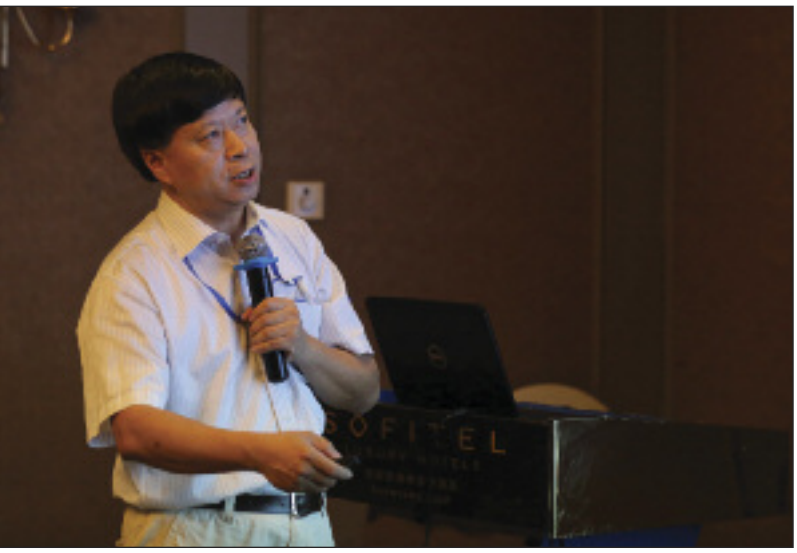
that year, China produced about 50 kg of carbon fibres, mostly used for military purposes.

Then between 1975 and 2000, China spent a total of RMB104 million (approximately US$13 million, based on the average exchange rates for 2000) on carbon fibres:

- RMB70 million was spent in the 1980s to buy two units for pre-oxidation and carbonation by Beijing University of Chemical Technology and the state-owned PetroChina Jilin Petrochemical Co of Jilin, China, from RK Carbon Fibres Ltd of Muir of Ord, UK, now part of the SGL Group;
- RMB34 million was spent on R&D, mostly conducted at several different universities.

The goal of buying the units was to accelerate the development of the industry by getting it to use technologies from developed countries. The units were installed in Beijing and Jilin province, but were never fully commissioned, which is considered one of the major setbacks in the history of the Chinese carbon fibre industry.

At the same time, the R&D activities had little impact on manufacturing for the reasons cited above. As a result, by 2000, only a few Chinese companies were able to produce carbon fibres, with a combined capacity of 30–40 t a year.



Despite being one of the first to conduct research into carbon fibre, as early as 1962, little commercial progress was made until the material was listed for the first time in China's national plan of 1975, says Professor Xu Jian (above).

Unlocking the industry's potential

Since the mid-2000s, China has been working to fix the problems and break the bottleneck that inhibits growth of the industry. In 2005, for instance, China Composites Group Co Ltd (CCGC), a subsidiary of the state-owned China National Building Material Group (CNBM), both based in Beijing, set-up a joint venture called Zhongfu Shenying Carbon Fiber Co Ltd (Zhongfu Shenying) of Lianyungang, China, with a private company, Yingyou Group and another state-owned company, Aoshen Group, also of Lianyungang. Zhongfu Shenying set-up a strong team for connecting R&D with production and adjusted its strategies to cater for market demands. Since then, the company has endured a tough journey that saw it take 11 years before it started to make profits.

In 2007, Zhongfu Shenying launched China's first T300-grade carbon fibre line, which boasted a capacity of 100 t a year. Zhongfu Shenying produces a series of carbon fibres with similar performance to Toray's T300 grades, including the ST350 (tensile strength: 3.5–4.0 GPa; tensile modulus: 220–240 GPa; elongation at break: 1.5; density: 1.76 $g.m^{-3}$; monofilament diameter: 7 µm).

To fight back against its emerging competitor, Toray significantly lowered its price for T300 fibres in the Chinese market, while maintaining high prices for its high-end products such as the T700 grades. This strategy worked well for the Japanese manufacturer and Toray successfully defended its market share for T300 products while securing profits on the expensive higher grades. Zhongfu Shenying was forced to follow the price reduction, which caused financial losses and inhibited the company's growth. In 2008 and 2009, China consumed a total of 8.2 kt and 8.6 kt of carbon fibres, respectively, but only 200 t a year were supplied by Chinese companies, about half supplied by Zhongfu Shenying.

In response to Toray's strategy, Zhongfu Shenying turned to making higher-grade ST700 carbon fibres (tensile strength: 4.5 GPa; tensile modulus: 240 GPa; elongation at break: 1.9), launching a production line in 2012 with a capacity of 1 kt a year. Although the T700 products helped Zhongfu Shenying increase its market share, the company made no profits before

2016, reporting consecutive losses for nine years in a row from 2007 to 2015.

One of the main reasons that Zhongfu Shenying survived this difficult period was its links to the Government. Its largest shareholder is CCGC, itself a subsidiary of CNBM, the world's 243rd largest company according to the 2017 Fortune 500 list. With the backing of CCGC and CNBM, Zhongfu Shenying enjoyed an investment of approximately RMB1.6 billion (about US$240 million) in its carbon fibre business ibetween 2007–2015.

In 2016, Zhongfu Shenying built a 1-kt-a-year production line for T800 precursors and a 100-t-a-year line for T800 carbon fibres. The establishment of this precursor line marks the point when China broke its bottleneck on precursor quality. In 2017, the company scaled-up its capacity for T800 carbon fibres to 1 kt a year. Zhongfu Shenying made a small profit (a few tens-of-thousands of dollars) in 2016 and reports that the increased capacity in 2017 has further strengthened its finances in the succeeding two years.

However, Zhongfu Shenying was not the first Chinese carbon fibre supplier to make profits. Weihai Guangwei Composites Co Ltd (Guangwei) of Weihai, China, another leading player, has been doing so since the early 2010s, mostly from T300-grade carbon fibres supplied to the China Air Force. In 2018, about 51% of Guangwei's sales were for military purposes. In contrast, Zhongfu Shenying is China's largest supplier of carbon fibres for commercial applications.

The complete picture

In the mid-2000s, several other Chinese companies announced ambitious plans for the establishment of facilities, each with an annual capacity of more than 10 kt, that were to be completed in just a few years. All of them fell well short of these targets and some companies disappeared after the rush of investment characteristic of that period melted away, bankrupting themselves as they failed to provide competitive products.

Currently, there are approximately 30 carbon fibre producers in China and the country's total annual capacity reached 26 kt by the end of 2018, with further expansion anticipated over the next few years.

The six largest Chinese carbon fibre producers are:

- Zhongfu Shenying—capacity of 6 kt a year, with plans to expand to 26 kt a year;
- Jiangsu Hengshen Co Ltd (Hengshen) of Zhenjiang—5 kt a year;
- Zhejiang Jinggong Science & Technology Co Ltd of Zhejiang—3.5 kt a year, with ambitions to increase this to 12 kt a year;
- Guangwei—3.1 kt a year;
- Zhonganxin Technology Co Ltd—1.8 kt a year, currently, while hoping to reach 5.1 kt a year;
- Lanzhou Bluestar Co Ltd of Beijing[1]—1.6 kt a year.

Combined, therefore, these six companies have a total capacity of 21 kt a year and account for more than 80% of China's carbon fibre capacity. The remainder divide-up a small share, but some also have significant expansion plans over the next few years.

Consumption and production

China's consumption of carbon fibres was approximately 23.5 kt in 2017, up from 19.5 kt in the previous year, according to Wang Hui, an analyst for Qianzhan, a China-based market research firm.

The market was still dominated by foreign suppliers, with nearly 16.1 kt (68.5% of total consumption) imported in 2017. Domestic companies, meanwhile, supplied 7.4 kt, more than double the amount (3.6 kt) in 2016. This growth of domestic companies was impressive considering China's production was only 2 kt as recently as 2014, when it imported nearly 12.8 kt.

This means Chinese suppliers enjoyed a compound annual growth rate (CAGR) of 54.7% between 2014 and 2017, while their foreign counterparts (such as Toray, Zoltek and SGL) only had a CAGR of 7.9% and the whole Chinese carbon fibre market grew at a CAGR of 16.7%. Consequently, the market share of domestic manufacturers increased from 13.5% to 31.5% in just three years.

The data for 2018 is not yet available, but experts believe these trends will continue and predict

domestic manufacturers will enjoy a CAGR of 25–30% from 2017 to 2020. Further, several sources, including Qianzhan, predict that the corresponding CAGR for foreign suppliers could be as low as about 3%, while the whole Chinese carbon fibre market will grow at a CAGR of 12–14%. If true, the market share of domestic suppliers, in terms of sales volumes, could get close to 50% by 2020.

The strong growth of Chinese companies is mainly thanks to consumer products. Data from Qianzhan shows that about 51.1% of carbon fibres, in terms of volume, were used for making sports products in China in 2017, much higher than the global average of 15.7%.

At the same time, only 13.0% were used for wind turbine blades, and 3.8% for aerospace products, much lower than the global averages of 23.5% and 22.8%, respectively.

This difference in the consumption patterns between China and the rest of the world is the result of several factors:

- China is the world's largest manufacturer of sports products. It is estimated that China produces more than 70% of the world's sports products, according to several reports published by the government and Chinese market research companies. Consequently, China consumes a large volume of carbon fibres for making sports products. Sales of these cheap T300-grade carbon fibres made by domestic producers are the main factor contributing to the CAGR of 54.7% reported above;
- most of the Chinese manufacturers still produce T300-grade carbon fibres at relatively low quality, which are mainly used for making sports products. High-end carbon fibres are still dominated by Toray and the other leading global suppliers, who sell at premium prices, which in turn dampens the demand in industries that require higher-quality grades, for example the aerospace and wind-power industries.

As Chinese suppliers increase the quality and output of their products, the prices of high-grade carbon fibres could decline significantly in the near future, which will boost China's consumption for carbon fibres in these high-

end applications. Currently, for instance, Chinese manufacturers have reduced the manufacturing costs of T700 and T800 carbon fibres to around RMB200 (about US$29) and RMB350 (US$50) per kilogramme, respectively. Further cost reductions are expected in the next few years, together with improvements in performance, which will no doubt boost the consumption and production of made-in-China carbon fibres.

Regional influences

Production and consumption of carbon fibres in China is concentrated in only a few of its regions. Mainland China has a total of 31 province-level regions: 22 provinces, four province-level municipalities (cities), and five province-level autonomous regions. On the production side, most of its carbon fibre capacity is located in three provinces:

- Jiangsu (12 kt a year);
- Jilin (4.1 kt a year);
- Shandong (3.1 kt a year).

Combined, therefore, these three provinces accounted for 73.8% of China's total annual capacity of 26 kt in 2018. The two largest carbon fibre producers, Zhongfu Shenying and Hengshen, are located in Jiangsu province.

On the consumption side, Guangdong, Shandong, Shanghai and Jiangsu are the largest province-level regions. They consumed, respectively, 5.6 kt, 5.3 kt, 3.2 kt and 3.1 kt of carbon fibres in 2017, accounting for 73.2% of China's total consumption, according to Wang. Guangdong is the largest for producing sports products.

References

[1] *Technical Textiles International*, July 2015, *Technical Absorbents targets superabsorbent nonwovens*, page 17; https://www.technical-textiles.net/node/71510

Further information

Toray Industries.
https://www.toray.com

Zoltek.
https://zoltek.com

SGL Carbon.
https://www.sglcarbon.com/en/company/about-us/company-profile/composites-fibers-materials

Professor Xu Jian, Institute of Chemistry, Chinese Academy of Science.
Tel: +86 (10) 8261-9667.
Email: jxu@iccas.ac.cn; http://www.ic.cas.cn

Beijing University of Chemical Technology.
http://english.buct.edu.cn

PetroChina Jilin Petrochemical Co.
http://www.petrochina.com.cn

China Composites Group Co Ltd.
http://www.ccgc.com.cn/en

China National Building Material Group.
http://www.cnbm.com.cn/en

Zhongfu Shenying Carbon Fiber Co Ltd.
Tel : +86 (518) 8607-0008.
Email: xiep@zfsycf.com.cn

Zhongfu-Shenying Europe Srl.
Tel: +39 (0328) 657-7284.
Email: nadiabosis@nadalia.it
http://www.zfsycf.com.cn/en

Jiangsu Aoshen Hi-Tech Materials Co Ltd.
http://www.asxc.com.cn

Yingyou Group
http://www.zglcn.net

Weihai Guangwei Composites Co Ltd.
http://www.gwcfc.com/en

Jiangsu Hengshen Co Ltd.
https://www.hscarbonfibre.com/cn

Zhejiang Jinggong Science & Technology Co Ltd.
http://www.jgtec.com.cn/home.php/en

Zhonganxin Technology Co Ltd.
http://www.zaxgroup.com

Lanzhou Bluestar Co Ltd.
https://bluestar.chemchina.com

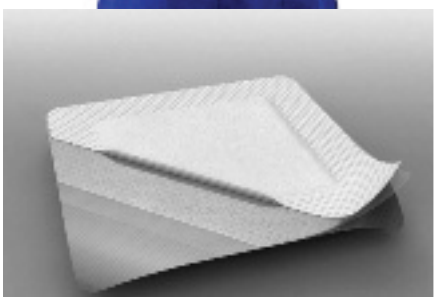
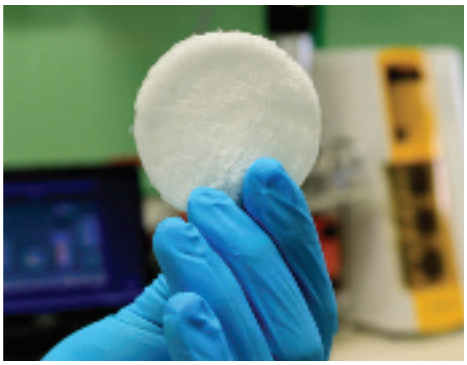
Qianzhan.
https://www.qianzhan.com

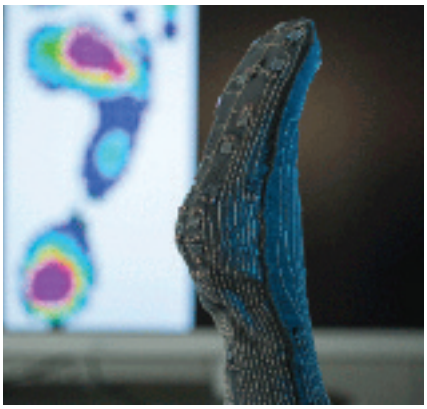
Medical Textiles

Fibres, yarns and fabrics for medical applications

Medical Textiles is a monthly printed and online publication which will keep you up-to-date with the technical and commercial developments of fibres, yarns and fabrics for medical applications.

Articles feature full technical specifications with illustrations, covering the latest news in wound treatment, surgical, orthopaedics, orthoses, medical sensors, prosthesis, hygiene, infection control, research findings, patents, business news, events and much more.




NEW: More patents analysed and explained

Medical Textiles is the only medical textiles news source covering the **latest patent publications**. Our expert authors skilfully refine these publications to produce easy-to-understand articles rich in technical detail. These items will give you an early look at the technologies your competitors are developing, years before they are commercialized.

To download your free sample issue and subscribe today, visit **www.technical-textiles.net** for further information.

Technical TEXTILES .net

www.technical-textiles.net

Learning how to print sensors onto stretchable substrates

Spanish researchers have been investigating how to select the best substrates, inks and deposition methods, as well as optimal designs in order to exploit the printing of sensors onto textiles. They report their preliminary findings for *Technical Textiles International*.

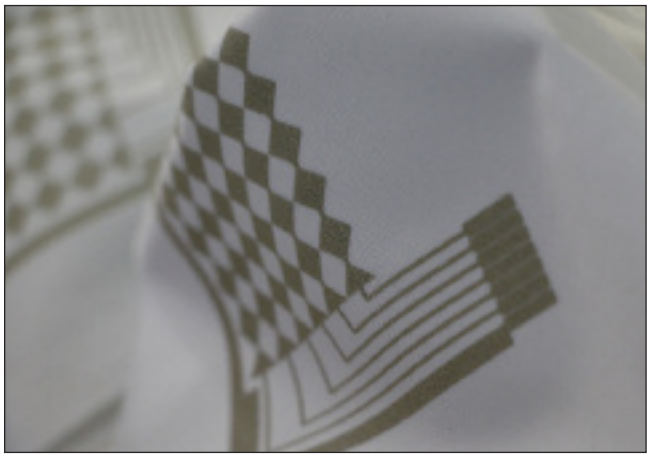
Electronics that can bend, stretch and flex are becoming more important as technology is integrated into our clothes, our environments and our bodies, and more and more wearable devices are being developed to satisfy an increasing number of applications. For wearable devices, the interfaces and sensors can be considered as the essential ingredients.

To integrate flexible electronics into fabrics, two principal approaches have been adopted: introducing conductive fibres into the textile construction in an appropriate pattern; printing the desired pattern on the fabric using a flexible conductive ink[1].

Printing electronics on flexible substrates has attracted particular interest in recent times owing to its potential use across a broad range of applications, such as the production of flexible display screens and devices that can conform to the skin. It is also a cheap way to make such devices compared with rival methods. Further, existing application methods, such as screen printing, can be readily adapted for the use of conductive inks.

Despite these advantages and the potential offered by industry's growing desire to develop smart textiles, the printing of electronics onto textiles is still in its earliest stages. More needs to be understood about the selection of the substrate to be used as the basis for printing, each one having distinct characteristics that will have an impact on the final product. In addition, more needs to be learned about the inks, their deposition and the circuit designs, as well as how these factors are affected by the flexibility and elasticity of the substrates.

To address these gaps in knowledge, the *Flexitex* project was established as a collaboration between the Textile Research Institute of Alcoy and the Inter-University Research Institute for Molecular

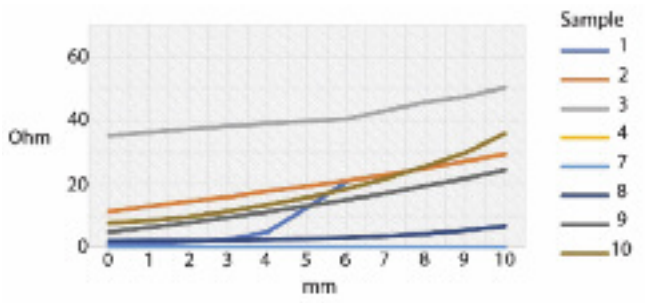


The application of printed conductive inks to textiles is hindered by a lack of fundamental knowledge about the selection of substrates, inks and deposition methods, as well as the design of appropriate circuits. Spanish research aims to address this lack of understanding.

Recognition and Technological Development (IDM) at the Universitat Politècnica de València, both in Spain. Its aim was to develop the means to print conductive inks based on organic materials onto flexible and stretchable substrates, with the specific goal of creating several sensors integrated with textiles.

In addition, this required the development of ways to apply multiple layers to the flexible substrates in order to create sensors made from combinations of conductive, dielectric and resistive materials. The project also set out to analyse the electronic properties of the resulting sensors, and their ability to flex and stretch.

The project required the use of the most recently introduced commercially available inks and aimed to find ways to improve their elasticity once applied to the substrates. It also addressed the challenge of encapsulating the printed circuits in order to protect them from the rigours of everyday use.



The researchers printed conductive circuits onto stretchable substrates and measured the resistance (in Ohms) of each sample as it was extended from 0 to 10 mm in incremental steps of 1 mm.

Studying printed electronics

Initially, tests were conducted to characterize different inks when applied to a variety of different substrates, evaluating the optimum temperatures and times for curing. Following the manufacturer's recommendations, inks were cured at 130°C, but the curing time was increased depending on the thickness of the applied layer.

The project also studied the effects of the orientation of the design with respect to the underlying substrate, with prints applied along three directions—0°, 45° and 90°. In addition, the work sought to understand the effects of fabric roughness, and the compatibility of the inks with the fabric materials and any surface finishes.

At the same time, the adhesion and conductivity of different inks to several elastic substrates were evaluated, and the allowable degree of extension assessed by measuring the variations in conductivity produced by stretching. For this work, identical patterns were printed on elastic substrates using different inks. The substrates were based on polyurethane (PU) films, owing to the material's favourable dielectric properties and the homogeneous surfaces that could be produced. Finally, the choice of PU allows the circuits to be protected simply by heat-sealing another PU film to the substrate in order to enclose the printed design between the two layers.

Determined by an extensometer, the samples were stretched in increments of 1 mm from 0 to 10 mm. The results showed that the resistance increased as more stress is applied to the conductive printed ink.

To check the effects of the heat-sealing as protection, samples were stretched to 10% and their resistances were determined before and after a protective film had been applied. In all cases, the resistance was higher, and so the conductivity lower, without the protection. The project concluded, therefore, that this simple heat-sealing is a good option for protecting the printed circuit.

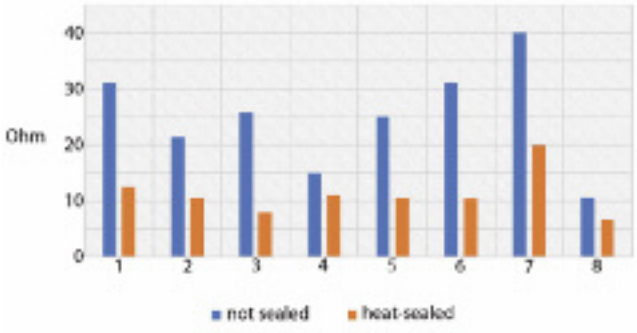
Nevertheless, the project also investigated applying moulds of resins and silicones to the substrates and succeeded in creating a waterproof encapsulation that further improved the durability and level of protection offered to the printed circuit. However, the results can then depend on the substrate/fabric since it is only this layer that protects the lower surface of the circuit.

Finally, the behaviour of combinations of conductive and resistive inks were studied, with a view to making products such as heated substrates. The work evaluated different substrates and succeeded in creating surfaces with good temperature homogeneity.

Product development

Based on the preceding work, the project next developed two electronic products using textiles as the substrates:

- a haptic sensor for detecting hand gestures in three dimensions;
- a regulated heated textile combined with a temperature sensor.



The researchers compared the resistance (in Ohms) of a number of samples that were stretched by 10% before and after the application of heat-sealed films designed to protect the circuits, and concluded that in all cases, the protection had the desired effect of reducing the resistance (increasing the conductivity).

The haptic sensor is designed for use in remote controls for such as televisions and is printed onto a fabric. It can recognize gestures and is capable of motion tracking. It can also detect rotations, approaches and directions of movement, and can respond to touching and double tapping at any of the points on the pad.

The second heated textile employs a sensor to measure the temperature of the wearer and a major problem with this element of the work was identifying the best substrate for contact with the skin. The device also has a heating zone, based on a flexible and stretchable printed circuit. The project team was able to develop the design so as to be more comfortable to wear than existing products of this kind, which cannot be fully integrated into fabrics. Further, because the heating zones are distributed in small cells, it offers better control of the heat across the surface compared with other heated textiles, which rely on the inclusion of conductive yarns.

Both these prototypes are stretchable and waterproof, according to the definitions set out in the project.

Summary

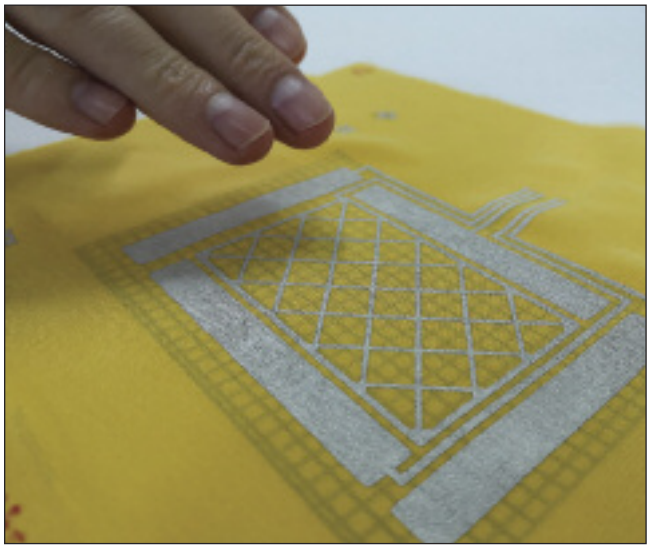
The results of tests carried out in the project using stretchable conductive and resistive inks have helped our understanding of how to design more durable circuits on flexible substrates, including textiles. In addition, means to protect the electronics printed on fabrics have been established.

Important factors in ensuring the reproducibility of electronic structures printed on textiles are:

- understanding how to optimize the application of the inks;
- the design and careful selection of substrates to facilitate the application of the inks and to promote homogeneity.

In addition, it was found that not only can the electronic circuits can be printed directly onto the textiles, but they also be applied to plastic films, which are then heat-sealed to the substrates.

Finally, the principal objective of the project has been achieved with the application of the knowledge gained to develop two sensor-based devices that exploit the printing of electronic inks onto fabrics.



A haptic sensor printed onto a fabric and designed for use in remote controls for such as televisions has been developed by the Flexitex researchers.

References

[1]Ferri, J; Moreno, J; Martinez, G; Lidón-Roger, JV; and Garcia-Breijo, E. (September 2017). *Printed Textile Touchpad*. In *Proceedings of the Eighth International Conference on Sensor Device Technologies and Applications* (SensorDevices2017), Rome, Italy (pages 10–14). http://www.iaria.org/conferences2017/SENSORDEVICES17.html

See also: https://www.iaria.org/conferences2019/SENSORDEVICES19.html

Further information

Josue Ferri, Jorge Moreno, Ana Rodes and Elena Mira, Textile Research Institute (Aitex).
Tel: +34 (96) 554-2200.
Email: josue.ferri@aitex.es

Neus Jorda, Head of Communication, Textile Research Institute (Aitex).
Email: njorda@aitex.es;
https://www.aitex.es

Eduardo Garcia-Breijo, Inter-University Research Institute for Molecular Recognition and Technological Development (IDM), Universitat Politècnica de València.
Tel: +34 (96) 387-7343. Fax: +34 (96) 387-9349.
Email: egarciab@eln.upv.es;
http://www.uv.es/idm

Technical Textiles International Buyers Guide

IN PRINT AND ONLINE:

A worldwide, comprehensive, technical textiles buyers guide from the publishers of Technical Textiles International.

A fully searchable interactive guide to the major worldwide companies supplying, producing and finishing technical textiles

- Major companies highlighted
- Freely accessible online
- Full addresses
- Indexed by activity and by country
- Over 1000 companies worldwide

To advertise in the next Buyers Guide contact our ad sales representative Maria Box today:
Tel: +44 (0)1273 423512 Email: dkay@fastnet.co.uk

IN PRINT:

AND ONLINE:

Buyers Guide Sections

Textiles
Fibres/filaments/yarns and threads
Woven and knitted fabrics
Nonwovens
Coated and laminated fabrics
Composites
Raw materials and chemicals

Machinery and equipment
Fibre/filament and yarn machinery
Nanofibre machinery
Weaving machinery
Knitting machinery
Narrow fabric machinery
Nonwoven machinery
Other production machinery
Finishing/processing machinery
Control/testing machinery
Recycling equipment

Textiles and textile-based products by market
Agricultural/horticultural
Architecture/building and construction
Clothing technology
Domestic
Environmental
Filtration
Geotextiles
Industrial
Medical and hygiene
Packaging
Safety and protection
Sports and leisure
Transportation

Services
Association/trade body
Publisher
Event organizer
Educational centre
Consultant
Testing/certification centre
Standards body
Research centre

Visit www.technical-textiles.net to access the guide today

High-performance monofilaments based on advanced biopolymers

By extruding biopolymers, Spanish researchers have successfully made polymeric optical fibres with unique geometries and biomaterials for tissue engineering. The team behind the *Volfil* project reveals its findings to *Technical Textiles International*.

Of the 1339 plastics companies operating in Spain's Valencian Community, 63 are focused on the extrusion of tapes and monofilaments. With the aim of supporting these businesses, two research institutes within the Community – the Textile Research Institute (Aitex) of Alcoy and the Institute of Telecommunication and Multimedia Applications (iTEAM) at the Universitat Politècnica de València, València – have collaborated to develop extruded products with novel properties made from biopolymers.

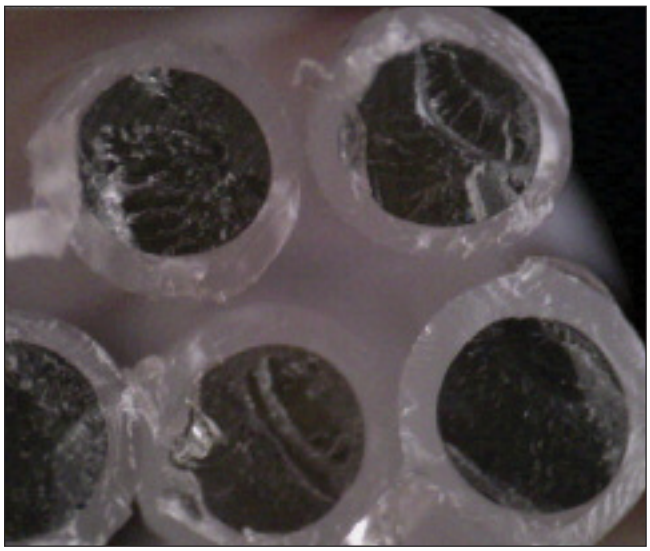
The resulting *Volfil* project then identified two applications – polymeric optical fibres (POFs) with special geometries and biomaterials for tissue engineering – for which it succeeded in developing products.

Polymeric optical fibres

Interest in the development of advanced optical sensors by means of adapting POFs is growing, owing to the vast array of possible applications in different fields such as textiles, medicine and civil engineering.

Compared with traditional electronic sensors, optical sensors hold many advantages, particularly:

Building on the knowledge gained from extruding circular cross-section polymer optical fibres, the team developed a version with a unique tri-lobal geometry.



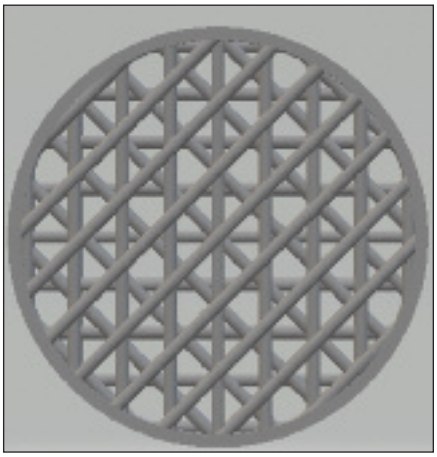
By extruding core–sheath bicomponent monofilaments, the team was able to create a polymer optical fibre with a circular cross-section. The researchers then refined the extrusion parameters in order to make optical fibres with minimal light losses.

- they are unaffected by electromagnetic radiation;
- the do not generate electromagnetic fields of their own that would otherwise interfere with nearby electronic devices, such cardiac pacemakers;
- they do not need a power source;
- they are lightweight and small.

The *Volfil* project sought to exploit these advantages to develop a prototype mattress capable of tracking the vital signs of someone lying on its network of advanced sensors made of POFs.

The first commercially available POF (ESKA) was produced by Mitsubishi Chemical Corp of Tokyo, Japan, using a two-step process:

- the extrusion of a monofilament of polymethyl methacrylate (PMMA);
- coating the PMMA monofilament with a thin film of polyvinylidene fluoride (PVdF) to create a laminate.



The circular scaffold design has a diameter of 8 mm, a height of 1.5 mm and 75% porosity (see also, page 38).

Volfil aimed to simplify the synthesis of the POF into a single step by coextruding the materials in a core–sheath configuration. This would not only reduce the costs of production, but also allow for the creation of new geometries leading to potentially novel applications—possibilities that have not been explored yet.

The material most commonly used for fabricating POFs is a PMMA grade known as Plexiglas, an amorphous transparent material supplied by Mitsubishi Chemical's subsidiary Lucite International of Billingham, UK. Plexiglas' increasing popularity is a result of its high degree of flexibility and mechanical properties, which allow the POFs to be incorporated in fabrics.

Our findings

Bicomponent fibres were successfully developed in a circular core–sheath configuration. Light losses from the resulting POFs were measured and correlated with the processing parameters. The researchers were then able to refine the process in order to minimize light losses.

Once the process was optimized for circular fibres, new dies with special internal geometries were designed in order to explore the potential of novel geometries, such as bicomponent fibres with three lobes. Again, the processing parameters for the POFs with novel geometries were adjusted to minimize light losses.

Finally, the POFs with the three-lobe geometry were integrated in a basic fabric construction so as to be able to locate accurately every tracking point required. The result was a prototype mattress capable of tracking the vital signs of someone lying on it.

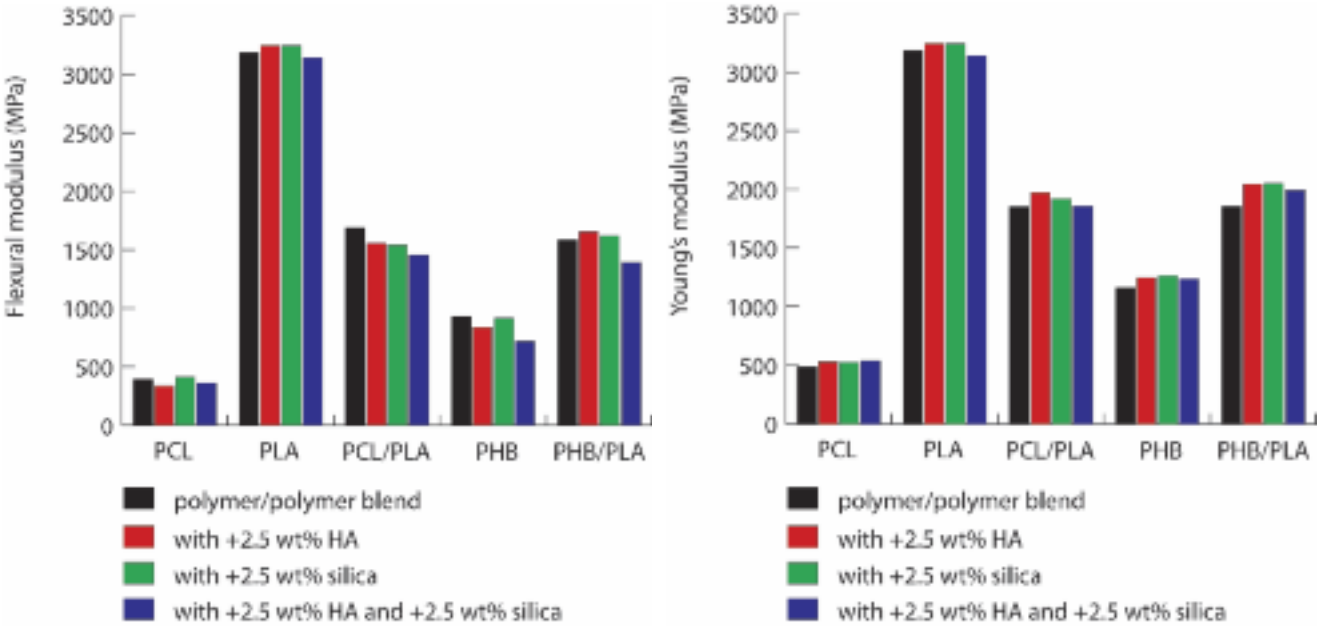
Biomaterials for tissue engineering

Skull injuries are the most frequent physical injuries encountered in urban trauma centres, and they are commonly suffered by elderly people and lead to an increased risk of such patients having strokes, one of the principal causes of death and disability worldwide. Consequently, the trend towards an ageing world population[(1)] makes this type of injury an even more important issue.

	Polymers		***Blends***
1	PCL	3	PCL/PLA
1a	PCL + 2.5 wt% HA	3a	PCL/PLA + 2.5 wt% HA
1b	PCL +2.5 wt% silica	3b	PCL/PLA +2.5 wt% silica
1c	PCL+ 2.5 wt% HA + 2.5 wt% silica	3c	PCL/PLA + 2.5 wt% HA + 2.5 wt% silica
2	PLA	5	PHB/PLA
2a	PLA + 2.5 wt% HA	5a	PHB/PLA + 2.5 wt% HA
2b	PLA +2.5 wt% silica	5b	PHB/PLA +2.5 wt% silica
2c	PLA + 2.5 wt% HA + 2.5 wt% silica	5c	PHB/PLA + 2.5 wt% HA + 2.5 wt% silica
4	PHB		
4a	PHB + 2.5 wt% HA		
4b	PHB +2.5 wt% silica		
4c	PHB + 2.5 wt% HA + 2.5 wt% silica		

The polymers, polymer blends (50 wt%/50 wt%) and the polymers/polymer blends with additives prepared for these studies (see also, page 38).

A comparison of the mechanical properties (Flexural modulus and Young's modulus) of the pure polymers, polymer blends and polymers with additives (see also, page 38).

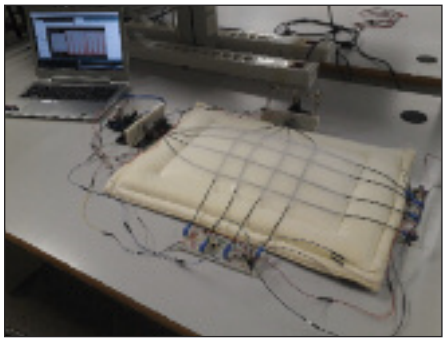


Accordingly, large levels of effort are being focused on the research of novel biomaterials capable of fulfilling the requirements for bone-fracture remodelling. Within the *Volfil* project, the researchers set-out to develop continuous monofilaments based on biopolymers that are biodegradable and bioabsorbable, as well as containing inorganic filler additives. Such monofilaments were to be used in three-dimensional (3D) printers to create scaffolds for tissue engineering, with the resulting materials needing to have good mechanical properties, as well as the ability to promote the regeneration of bone.

The use of biomaterials is an alternative to traditional bone-repair techniques and leads to faster healing of the injuries. Bioabsorbable synthetic polymers such as polycaprolactone (PCL), polylactic acid (PLA) and polyhydroxybutyrate (PHB) are broadly used in biomedical applications, owing to the ease with which they can be processed and their biocompatibility. Loading the polymer matrix with nanoparticles such as hydroxyapatite (HA) and nanospheres of silica (SiO_2) is one way to improve the efficiency of cell adhesion, bone regeneration and mechanical properties.

In fact, HA is the most abundant material found in human bones and is a cheap biocompatible filler that guarantees compatibility with and facilitates regeneration of natural bone. Aiming to mimic body tissues, PCL, PLA and PHB must display adequate mechanical stiffness to resist *in vivo* stresses and so prevent deformation of new tissue.

The required mechanical properties can be met by the appropriate addition of HA and/or SiO_2 to the polymer matrix. Indeed, PCL, PLA and PHB have been already reinforced with HA, increasing tensile strengths by up to 38%, 150% and 40%, respectively. This enhancement of mechanical properties is ascribed to a synergistic effect produced by strong interactions between the polymer matrix and the filler surfaces.



By integrating the polymer optical fibres into a prototype mattress, the researchers have successfully developed a sensor capable of monitoring the vital signs of a patient lying on it.

Within the *Volfil* project, the researchers investigated the affinity and viability of cells on the material's surface, as well as the biocompatibility, biodegradability in a physiological environment and mechanical properties of the material, correlating these to levels of added inorganic fillers.

Our findings

In the first stage, 20 different compositions were prepared in a twin co-rotating extruder in order to ensure the most complete mixing between the components in each case. Pure polymers of PCL, PLA and PLB, as well as blends containing 50 wt% of one of these with 50 wt% of another, were used as controls, and their properties were compared with the other compositions, which all contained various amounts of the fillers as shown in the table (see also, page 36).

Subsequently, coils of monofilaments suitable for use in 3D printers were made from each of the compositions. Each monofilament had a diameter of 2.85 mm.

The researchers then 3D-printed circular scaffolds from all the compositions, each measuring 8 mm in diameter and 1.5 mm in height. Pore sizes were in the range 150–200 µm, but the overall porosity of each sample was 75%. For each composition, the 3D-printing parameters were optimized by adjusting such as the temperature and velocity. The samples were then sterilized and used to study the cytotoxicity, viability and biodegradability in a physiological environment of each composition (see also, page 36).

Mechanical properties

In the first phase, mechanical properties of the different compositions were assessed by measuring the Youngs modulus and flexural modulus (see also, page 37). Compared with the controls, these mechanical properties increased with the addition of the fillers HA and SiO_2 separately, but worsened slightly when the two fillers were combined. In addition, blends with PLA improved the mechanical properties compared with the pure materials (PCL and PHB).

Biological properties

The biological properties of the different polymers were also assessed in terms of their cytotoxicity and viability for cell growth. All the samples showed excellent viability—in other words they are all biocompatible. Further, in all the polymers containing HA, the viability of cell growth was enhanced. This is explained by the introduction of new reactive sites corresponding to the calcium (Ca^{2+}) and phosphate (PO_4^{3-}) ions present in the HA molecules, which promote interactions with the carboxyl and amino groups present in the proteins attached to the cells' surfaces and serve to support the cells.

In contrast, although still remaining good in all cases, the addition of SiO_2 in some polymers caused a slight decrease in the viability. This effect is produced by the hydrogen bound between the silanol groups (Si–OH) found on the surface of the SiO_2 and the carboxyl groups present in the cells' proteins.

In all cases, the addition of both fillers (HA and SiO_2) improved the viability, demonstrating a synergistic effect between the fillers and the polymers.

References

[1] *Technical Textiles International*, October 2018, *Textiles are vital to the growing needs of advanced wound care*, page 35;
https://www.technical-textiles.net/node/74368

Further information

E. Torres Textile Research Institute (Aitex).
Tel: +34 (96) 554-2200.
Email: etorres@aitex.es

Neus Jorda, Head of Communication, Textile Research Institute (Aitex).
Email: njorda@aitex.es;
https://www.aitex.es

Demetrio Sartiano, Instituto de Telecomunicaciones y Aplicaciones Multimedia (iTEAM), Universitat Politècnica de Valéncia.
Tel: +34 (62) 826-5006.
Email: tedesar@teleco.upv.es

Salvador Sales, Instituto de Telecomunicaciones y Aplicaciones Multimedia (ITEAM), Universitat Politècnica de Valéncia.
Tel: +34 (96) 387-9735.
Email: ssales@dcom.upv.es;
http://www.iteam.upv.es

September 2019

10–11 September
E-Textiles
Philadelphia, Pennsylvania, USA.
Chris Jorgensen, Director, Technology Transfer, IPC - Association Connecting Electronics Industries.
Tel: +1 (847) 597-2826.
Fax: +1 (847) 615-7105.
ChrisJorgensen@ipc.org
http://www.ipc.org

11–13 September
Dornbirn Global Fiber Congress
Dornbirn, Austria.
Dornbirn Global Fiber Congress Office.
Tel: +43 (1) 319-2909-41.
Fax: +43 (1) 319-2909-31.
office@dornbirn-gfc.com
http://www.dornbirn-gfc.com

24–25 September
Research, Innovation & Science for Engineered Fabrics (RISE)
Raleigh, North Carolina, USA.
Tracie Leatham, Association of the Nonwoven Fabrics Industry (INDA).
Tel: +1 (919) 459-3726.
tleatham@inda.org
http://www.riseconf.net

26–27 September
Textile Coating and Laminating Congress
Ghent, Belgium.
Karina Wageneire, Unitex.
Tel: +32 (9) 355-2388.
Fax: +32 (9) 356-7880.
secretariat@unitex.be
https://www.textilecoatingcongress2019.be

October 2019

1–4 October
IFAI Expo
Orlando, Florida, USA.
Jennifer Fisher, Industrial Fabrics Association International (IFAI).
Tel: +1 (651) 222-2508.
Fax: +1 (651) 631-9334.
jarfisher@ifai.com
http://ifaiexpo.com

16–17 October
Nonwovens Innovation Academy
Denkendorf, Germany.
Anaelle Schutz, EDANA.
Tel: +32 (2) 740-1811.
anaelle.schutz@edana.org
https://www.edana.org/education-events/conferences-and-symposia/event-detail/nonwovens-innovation-academy2019

22–24 October
Automotive Interiors Expo
Novi, Michigan, USA.
Jason Sullivan, Sales Director, UKi Media & Events.
Tel: +44 (1306) 743744.
Fax: +44 (1306) 742525.
jason.sullivan@ukimediaevents.com
https://www.automotive-interiors-expo.com/detroit/en/contact-us.php

22–24 October
Filtech
Cologne, Germany.
Suzanne Abetz, Managing Director, Filtech Exhibitions.
Tel: +49 (2132) 9357-60.
Fax: +49 (2132) 9357-62.
abetz@filtech.de
http://www.filtech.de

November 2019

5–8 November
A+A
Düsseldorf, Germany.
Messe Düsseldorf GmbH.
Tel: +49 (211) 4560-01.
Fax: +49 (211) 4560-668.
info@messe-duesseldorf.de
https://www.messe-duesseldorf.de

12 November
E-Textiles Europe
Munich, Germany.
Chris Jorgensen, Director, Technology Transfer, IPC - Association Connecting Electronics Industries.
Tel: +1 (847) 597-2826.
Fax: +1 (847) 615-7105.
ChrisJorgensen@ipc.org
http://www.ipc.org

18–19 November
EurAsian Geosynthetics Symposium
Beijing, China.
Anaelle Schutz, EDANA.
Tel: +32 (2) 740-1811.
anaelle.schutz@edana.org
https://www.edana.org/education-events/conferences-and-symposia/event-detail/eurasia-geotextiles-symposium-2019

20–22 November
Techtextil India
Mumbai, India.
Priyanka Pawar, Group Exhibition Head Textile and Consumer Shows, Messe Frankfurt Trade Fairs India Pvt Ltd.
Tel: +91 (22) 6144-5900.
Fax: +91 (22) 6144-5999.
priyanka.pawar@india.messefrankfurt.com
https://techtextil-india.in.messefrankfurt.com

February 2020

5–6 February
Textile Opportunities in a Changing Automotive Industry
Birmingham, UK.
Jill Gwinnutt, Marketing Manager, International Newsletters Ltd.
Tel: +44 (870) 165-7210.
jill.gwinnutt@intnews.com
https://www.technical-textiles.online/TOAI
See also, outside back cover

26–28 February
FiltXPO
Chicago, Illinois, USA.
Lori Reynolds, Director of Events, Association of the Nonwoven Fabrics Industry (INDA).
Tel: +1 (919) 459-3716.
lori@filtxpo.com
https://www.filtxpo.com

March 2020

3–5 March
JEC World
Paris, France.
Alice Ellenbogen, JEC Composites.
Tel: +33 (1) 5836-4399.
ellenbogen@jeccomposites.com
http://www.jeccomposites.com

31 March—3 April
INDEX
Geneva, Switzerland.
Delphine Rens, Marketing and Communications Coordinator, EDANA.
Tel: +32 (2) 740-1822.
Fax: +32 (2) 733-3518.
delphine.rens@edana.org
http://www.edana.org

May 2020

12–14 May
Techtextil North America
Atlanta, Georgia, USA.
Ali Rosenberger, Marketing & Conference Manager, Messe Frankfurt Inc.
Tel: +1 (678) 732-2428.
ali.rosenberger@usa.messefrankfurt.com
https://techtextil-north-america.us.messefrankfurt.com

November 2020

3–6 November
IFAI Expo
Indianapolis, Indiana, USA.
Jennifer Fisher, Industrial Fabrics Association International (IFAI).
Tel: +1 (651) 222-2508.
Fax: +1 (651) 631-9334.
jarfisher@ifai.com
http://ifaiexpo.com

Index to advertisers

Advertiser	page
Advanced Composites Bulletin	*1*
Advances in Textiles Technology	*24*
Advertise in Technical Textiles International	*20*
Buyer's Guide Online	*34*
Dilo	**5**
Free trial for Smart Textiles and Nanotechnology	*28*
International Newsletters	*Inside front cover*
Medical Textiles	*30*
Smart Textiles and Nanotechnology	*1*
Technical Textiles International	*Inside back cover*
Textile Opportunities in a Changing Automotive Industry	*Outside back cover*

Forthcoming advertising features

Issue	Advertising features	Bonus distribution	Order deadline
October	**Filtration** **Military** **Safety and protection** **High-performance garment care**	*Filtration; IFAI Expo* *Filtech; JEC Asia* *A + A; Milipol* *Aachen–Dresden–Denkendorf ITC* *Techtextil India*	30 August
December	**BUYER'S GUIDE** **Medical textiles** **Composites in construction** **Energy-storage technology**	*Shanghai International Nonwovens Conference and Exhibition* Major 2020 events	25 October

To advertise, contact: David Kay or Maria Box. Tel: +44 (1273) 423512. Email: dkay@fastnet.co.uk

Copyright statement and legal notices

ISSN 0964-5993: Printed in the UK by Blackmore, Shaftesbury.

Technical Textiles International is published in six issues a year: February, May, June, August, October and December, in one volume, by: International Newsletters Ltd, 44 Friar Street, Droitwich Spa, WR9 8ED, UK. The annual subscription in the USA is $459. Technical Textiles International is distributed by Blackmore Ltd, Longmead, Shaftesbury, Dorset, SP7 8PX, UK. Postmaster, please send address corrections to International Newsletters Ltd, 44 Friar Street, Droitwich Spa, Worcestershire, WR9 8ED, UK.

Technical TEXTILES international

Everything you need to know about textile materials and technology for high performance and advanced applications - every issue

Read Technical Textiles International and:

- keep track of the latest developments in new materials and processes
- identify market trends
- understand how technical advances hold the key to new markets
- identify new product development & applications
- keep abreast of new patents, standards & quality control measures
- exchange new ideas & build your business with the new contacts brought to you by the magazine's complete coverage of all sectors of the industry

Your subscription includes online access for up to 5 users: immediate worldwide access as soon as the issue is published

Subscribe for 2 years and save money

( ) **Yes! Please enter my order for Technical Textiles International:**

( ) 2 years: 12 issues **Print & online access** £582 / €757 / US$890

( ) 1 year: 6 issues **Print & online access** £300 / €390 / US$459

Customer Details:

Title: First name:

Last name:

Job Title:

Company name:

Address:

Post/Zip Code:

Country:

Telephone:

Fax:

Email:

VAT number (if registered):

Payment Details:

( ) I enclose a cheque payable to:
International Newsletters Ltd (£, € or US$ only)

( ) Please invoice me:
Purchase order number: _____

( ) Please charge my AMEX / VISA / Mastercard

Card number:

Expiry Date: Sec code:

Cardholder name:

Cardholder address if different:

Signature: Today's Date:

Return your completed form to:

International Newsletters Ltd, 44 Friar Street, Droitwich Spa, Worcestershire, WR9 8ED, UK

Tel: +44 (0)870 1657210; **Email:** sales@intnews.com; **Web:** www.technical-textiles.net

EARLY-BIRD DELEGATE REGISTRATION IS NOW OPEN

Textile Opportunities
in a changing automotive industry

Jaguar Experience Centre, Birmingham, UK
5-6 February 2020

Textile Opportunities in a Changing Automotive Industry is a new conference organized by International Newsletters to discuss the latest and future prospects for technical textiles and nonwovens in this fast developing sector.

This event will bring together the key players in the industry, from OEMs and Tier 1 and 2 suppliers to raw material manufacturers, as well as builders of textile and nonwoven manufacturing equipment. Presentations will examine in detail how current trends are already reshaping the automotive industry, and its supply chain, and will continue to do so in the next decade and beyond.

The conference will be held at the **Jaguar Experience Centre** in the heart of the UK motor manufacturing industry.

For further information and to register as a delegate or event sponsor at special Early-bird rates, visit www.technical-textiles.online/TOAI

Technical TEXTILES .net

www.technical-textiles.online/TOAI