June 2023 | Editor: Geoff Fisher

medicaltextiles

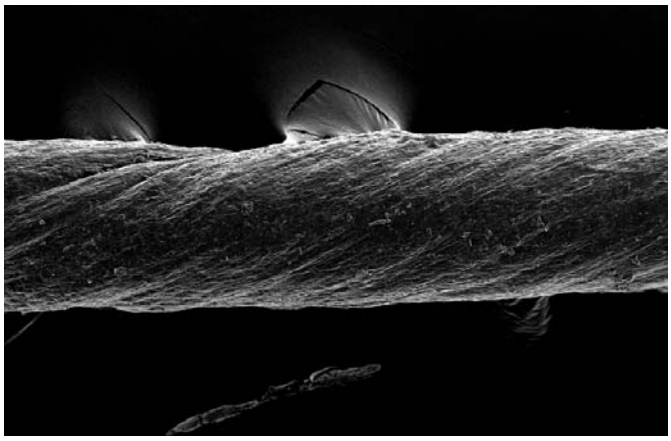
Sutures developed that can deliver drugs or sense inflammation

Engineers at the Massachusetts Institute of Technology (MIT) have designed "smart" sutures that not only hold tissue in place, but also detect inflammation and release drugs.

The new sutures are derived from animal tissue, similar to the "catgut" sutures first used by the ancient Romans. In a modern twist, the MIT team coated the sutures with hydrogels that can be embedded with sensors, drugs or even cells that release therapeutic molecules.

Giovanni Traverso, assistant professor of mechanical engineering at MIT, gastroenterologist at Brigham and Women's Hospital and senior author of the study published in *Matter*, said: "What we have is a suture that is bio-derived and modified with a hydrogel coating capable of being a reservoir for sensors for inflammation or for drugs such as monoclonal antibodies to treat inflammation. Remarkably, the coating also has the capacity to retain cells that are viable for a prolonged period."

The researchers envision that these sutures could help patients with Crohn's disease heal after surgery to remove part of the intestine. The sutures could also be adapted to heal wounds or surgical incisions elsewhere in the body.



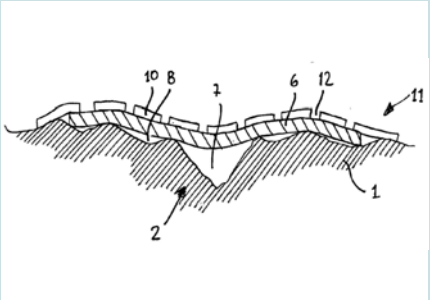
MIT engineers have designed tissue-derived "smart" sutures that can not only hold tissue in place, but also detect inflammation and release drugs. The sutures are coated with hydrogels that can be embedded with sensors, drugs or cells that release therapeutic molecules. Image: MIT

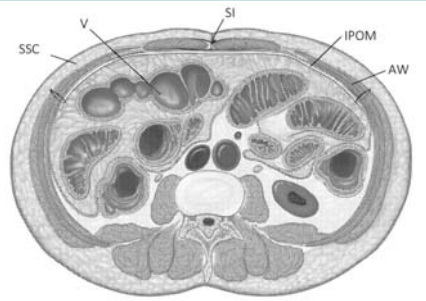
Inspired by catgut

Developed thousands off years ago, catgut sutures – which are made from strands of purified collagen from cows, sheep or goats (although not cats) – form strong knots that naturally dissolve within about 90 days. Although synthetic absorbable sutures are also available, catgut is still used in many types of surgery.

Traverso and his colleagues wanted to see if they could build on this type of tissue-derived suture to create a material

Highlights this month





that would be tough and absorbable, and have advanced functions, such as sensing and drug delivery.

Such sutures could be particularly useful for Crohn's disease patients, who need to have a part of the intestine removed owing to blockage from excessive scarring or inflammation. This procedure requires resealing the two ends left behind after one section of the intestine is removed. If that seal does not hold tightly, it can lead to leaks that are dangerous for the patient.

To help reduce this risk, the MIT team wanted to design a suture that could not only hold the tissue in place but also detect inflammation, an early warning sign that the resealed intestines are not healing properly.

The researchers created their new sutures from pig tissue, which they "decellularised" using detergents to reduce the chances of inducing inflammation in the host tissue. This process leaves behind a cell-free material that the researchers call "De-gut", which contains structural proteins, such as collagen, as well as other biomolecules found in the extracellular matrix.

After dehydrating the tissue and twisting it into strands, the researchers evaluated its tensile strength – a measure of how much stretching it can withstand before breaking – and found that it was comparable to commercially available catgut sutures. They also found that the De-gut sutures induce much less of an immune response from surrounding tissue than traditional catgut.

"Decellularised tissues have been extensively used in regenerative medicine with their superb bio-functionality," said former MIT postdoctorate Jung Seung Lee. "We now suggest a novel platform for performing sensing and delivery using decellularised tissue, which will open up new applications of tissue-derived materials."

Smart applications

Next, the researchers set out to enhance the suture material with additional functions. To do that, they coated the sutures with a layer of hydrogel. Within the hydrogel, they can embed several types of material – microparticles that can sense inflammation, various drug molecules or living cells.

For the sensor application, the researchers designed microparticles coated with peptides that are released when inflammation-associated enzymes – matrix metalloproteinases – are present in the tissue. These peptides can be detected using a simple urine test.

The researchers also showed that they could use the hydrogel coating to carry drugs that are used to treat inflammatory bowel disease, including a steroid called dexamethasone and a monoclonal antibody called adalimumab.

FDA-approved polymers

These drugs were carried by microparticles made from US Food and Drug Administration-approved polymers such as polylactic-co-glycolic acid and polylactic acid, which are used to control the release rate of drugs.

This approach could be adapted to deliver other kinds of drugs, such as antibiotics or chemotherapy drugs, the researchers say.

These smart sutures could also be used to deliver therapeutic cells, such as stem cells. To explore that possibility, the researchers embedded the sutures with stem cells engineered to express a fluorescent marker and found that the cells remained viable for at least seven days when implanted in mice. The cells were also able to produce vascular endothelial growth factor, which stimulates blood cell growth.

The researchers are now working on further testing of each of these possible applications and on scaling up the manufacturing process for the sutures. They also hope to explore the possibility of using the sutures in parts of the body other than the gastrointestinal tract.

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ISSN 1878-7002

Publisher:
Judy Holland
Textile Media Services Ltd
Homerton House, 74 Cawston Road
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Tel: +44 1603 308158
Email: jholland@textilemedia.com
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Medical Textiles is published 12 times a year.
For subscription details see last page

Dressing configured for nitric oxide delivery

A wound dressing that can generate nitric oxide has been developed by UK-based medical technology company Smith & Nephew.

Disclosed in US Patent 20230136007, the wound dressing (18000) comprises:

- a cover layer (18200);
- an acid-providing layer (18400) that comprises acidic groups;
- a nitrite-providing layer (18600) that comprises a nitrite salt.

The acid-providing layer can be a hydrogel or xerogel and be constructed from a mesh, a foam, a gel or any other material suitable for containing acid groups.

The dressing can also include other layers, such as an acquisition distribution layer (18800) to horizontally and/or vertically wick fluid and/or masking layers that can prevent visualisation of the layer below.

The nitrite ions of the nitrite-providing layer react with the acidic groups of the acid-providing layer to generate nitric oxide.

The acid-providing layer further includes one or more material layers to reduce the adhesiveness of the acid-providing layer, which can also include perforations.

According to Smith & Nephew, nitric oxide influences blood vessel vasodilation, stimulates angiogenesis, influences the host immune response and demonstrates potent, broad-spectrum antimicrobial activity and anti-biofilm activity. As a result, nitric oxide demonstrates a potent effect on tissue and increased amounts of it can support the acceleration of healing in wounds, particularly chronic wounds.

Figure 1 is a cross-sectional view of a wound dressing that generates nitric oxide to the peri-wound (18920) and/or the edge of the wound (18910). It shows the acid-providing layer at a border region, encompassing a central absorbent material (18450), which can include a foam or nonwoven natural or synthetic material (and optionally a superabsorbent material) that forms a reservoir for fluid removed from the wound site.

The central absorbent material can also aid in drawing fluids towards the cover layer and prevent liquid collected in the dressing from flowing freely within the dressing, thereby containing any liquid collected within the dressing.

The capacity of the absorbent material can be sufficient to manage the exudate flow rate of a wound when negative pressure is applied. In some embodiments, the central absorbent material can be chosen to absorb liquid under negative pressure.

Materials that can absorb liquid when under negative pressure can be manufactured from, for example, Allevyn foam, Freudenberg 114-224-4 or Chem-Posite 11C-450. Alternatively, the central absorbent material can include a composite comprising superabsorbent powder, fibrous material such as cellulose or bonding fibres.

For example, the composite can be an airlaid, thermally bonded composite or a layer of nonwoven cellulose fibres having superabsorbent material in the form of dry particles dispersed throughout.

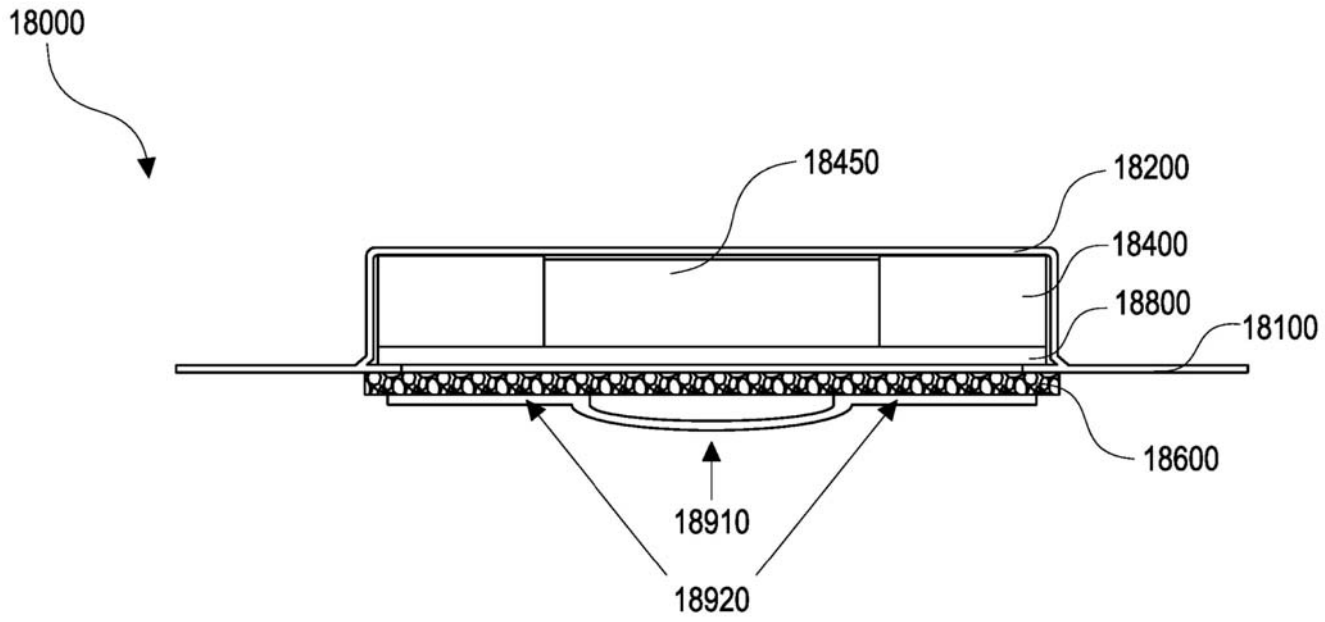

Figure 1: Cross-sectional view of a wound dressing that generates nitric oxide.

The wound dressing can further include a frame layer (18100) that further supports the acid-providing layer, positioned at a wound-facing side of the dressing and covering a border region of the dressing. The frame layer can be a polyurethane layer, a polyethylene layer or another suitable flexible layer.

See also: US Patent 20230136007, *Wound dressing*.

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Antimicrobial and non-adherent dressing

A wound dressing with antimicrobial and non-adherent properties has been developed by researchers from Vietnam National University and Ho Chi Minh City International University, Vietnam.

Outlined in US Patent 20230118969, the dressing is designed to provide scaffolding materials for granulation, re-epithelialisation and tissue formation, and further provides non-adherence to the wound to avoid pain and tissue damage upon removal.

The dressing comprises:

- a first layer (101) comprising polycaprolactone (PCL) fibres having a fibre diameter of 0.5–2.9 µm;
- a second layer (102), deposited directly on the first layer, including a mixture of PCL and poloxamer (POX) fibres with a fibre diameter of 0.1–4 µm;
- a third layer (103), deposited directly on the second layer, comprising a mixture of gelatin and the antimicrobial silver nitrate ($AgNO_3$), which makes direct contact with the epidermis layer (3223) of the wound (322).

The first layer has a thickness of 0.1–2 mm and a pore diameter of 7–20 µm, while the second layer has a thickness of 0.02–0.3 mm; these two layers can be formed by electrospinning.

The third layer is impregnated with a solution of gelatin and $AgNO_3$ by the immersion/overlay method. The gelatin has a concentration of 0.1–20% and the $AgNO_3$ has a concentration of 0.1–5%.

Upon application of the dressing, the second layer containing the PCL and POX fibres delivers the gelatin and $AgNO_3$ into the wound area according to a first direction (331). At the same time, the second layer draws excess exudate from the wound in a second direction (332), keeping the wound moist.

The POX component has the effects of:

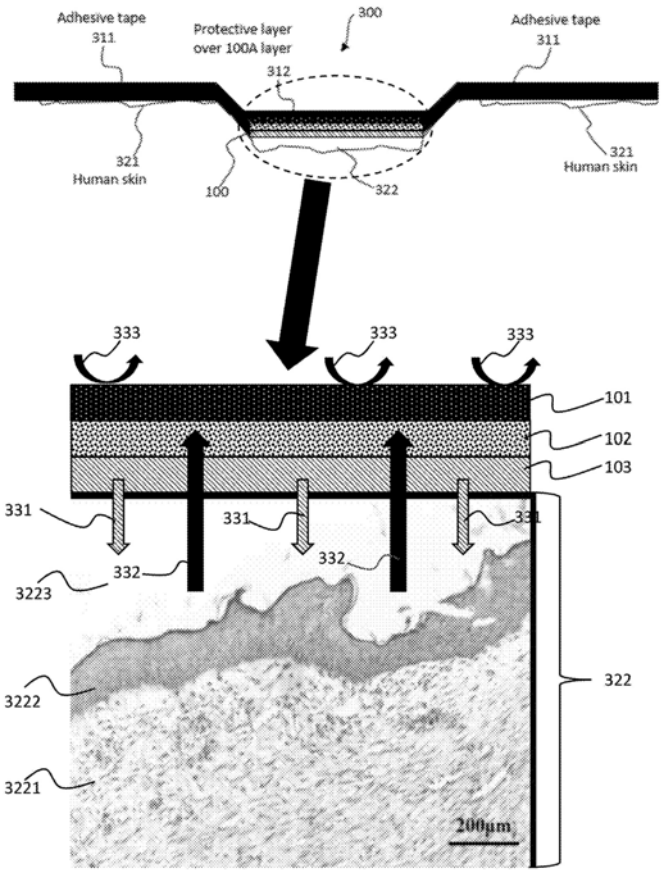

Figure 2: Side view showing the operations of the medical dressing developed by researchers in Vietnam.

- releasing the active ingredients into the wound area;
- drawing excess exudate from the wound to maintain optimal moisture;
- providing extracellular matrix scaffolding for granulation, tissue formation and re-epithelialisation.

Meanwhile, the hydrophobic PCL fibres in the first and second layers prevent contaminants and liquid containing bacteria or fluids from entering and infecting the wound in a third direction (333).

The researchers add that in many cases the second layer naturally adheres to the wound without the need for additional adhesives.

See also: US Patent 20230118969, *Wound dressing articles and method of manufacturing the same*.

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Antimicrobial dressing stimulates cell growth

An improved tissue dressing material that consists of chitosan or a chitosan-comprising composition has been developed by biotechnology company Medoderm of Mainz, Germany.

The dressing can be used to treat a microbial infection, and the chitosan is intended to stimulate the growth of epithelial cells, especially keratinocytes.

As US Patent 20230136330 explains, an effective amount of chitosan can be administered to a patient by providing an aqueous solution comprising chitosan.

The chitosan or chitosan-containing composition can be applied to the patient in vivo. Alternatively, it may be applied ex vivo to an epithelial cell-containing cell culture.

The treatment disclosed can:

- prevent the risk of a microbial infection;
- reduce the microbial load of an existing microbial infection;
- prevent or reduce the spread of a microbial infection.

Further, the chitosan or pharmaceutical composition can act as a barrier to a microbial infection from inside and outside the tissue being treated.

The chitosan or composition can be a liquid that is sprayed onto the tissue and the mixture medium or a solvent is subsequently allowed to evaporate to form a solid or gel-like film.

Alternatively, the chitosan or composition can be provided in a solid or gel-like form, for example as a hydrogel, and can have the shape of a fibre or tube.

The chitosan or pharmaceutical composition comprising chitosan can be applied as a wound dressing. Figure 3 illustrates a wound (2) to which a perforated wound dressing (11) that comprises a chitosan or chitosan-containing composition has been applied.

Here, a chitosan film (6) comprises a first layer, with a second layer of another material, that acts as a support to help prevent premature detachment of the dressing from the tissue (1). Cavities (7, 8) between the tissue and the chitosan can be filled with water or exudative fluid.

The support layer can be, for example, a woven fabric, foam or a perforated film, and made of natural materials, such as cotton, or a natural or synthetic polymer. A further layer can act as a partial moisture barrier.

Figure 3 shows the support layer as a silicon film (10) with a thickness of 10–50 µm and with perforations having a diameter of 50–100 µm.

See also: US Patent 20230136330, *Antimicrobial and/or epithelial cell growth stimulating substance and composition and tissue dressing material*.

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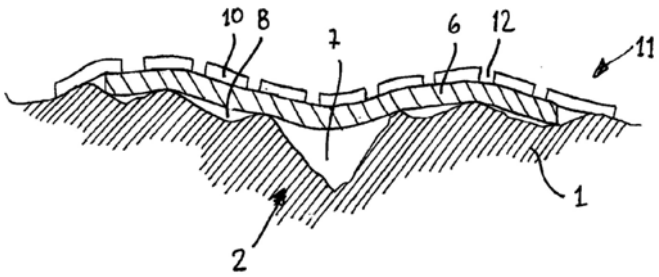

Figure 3: A wound to which a perforated wound dressing that comprises a chitosan or chitosan-containing composition has been applied.

Bioactive collagen wound dressings

A method for preparing cross-linked, bioactive, collagen-based medical scaffolds for wound care dressings, hernia repair prosthetics and surgical incision closure members is disclosed by medical technology company Ension of Butler, Pennsylvania, USA.

Featured in US Patent 11622892, the method comprises:

- immersing a sample of fibrous and/or non-fibrous collagen in a buffered acidic, aqueous solution comprising an alcohol;
- contacting the collagen in solution with a catalytic component comprising 1-ethyl-3-[3-dimethylaminopropyl]carbodiimide hydrochloride for a time to effect reaction between the amino and carboxyl groups present on the collagen and to yield cross-linked collagen that is resistant to pronase degradation;
- drying the cross-linked collagen to yield a porous, cross-linked collagen article with a pore size of 10–500 µm.

According to Ension, collagen-based wound dressings produced using the method disclosed in the Patent are designed to be non-antigenic and further augment the natural healing process and degrade within the wound in a controlled manner without producing by-products that generate an immune response.

Such dressings are said to form an improved haemostatic dressing for non-compressible wounds, i.e., wounds where pressure cannot be directly applied, therefore the dressing needs to stop the bleeding without any manual pressure application.

The haemostat features involve:

- a biological mechanism in which thrombin and collagen act as procoagulants to initiate spontaneous clotting;
- an adherent mechanism in which chitosan provides intimate wound coverage by adhering to the tissue and the haemorrhaging vessel due to its inherent positive charge (chitosan is also a bactericidal agent);
- an aggregate mechanism in which the nano-porous architecture of the sponge or scaffold facilitates the immediate absorption of red blood cells and platelets and their uniform distribution within the pores of the scaffold, which results in an interconnected network of cellular aggregates that enhances haemostasis and enables the formation of an effective uniform blood plug.

In addition, scaffolds for collagen-based hernia repair prosthetics further augment the natural healing process while providing sufficient strength and flexibility for the intended application while providing a solution that is said to be cost effective to manufacture and implement.

For incisional closure, the scaffolds provide a biological structure to reinforce a surgical incision to promote healing and reduce the occurrence of post-operative complications, such as incisional hernias.

See also: US Patent 11622892, *Methods of making bioactive collagen wound care dressings*.

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Fibre materials with improved properties

Fibre materials with improved mechanical properties, such as stability and integrity, particularly in moist or wet conditions, have been developed by Mölnlycke Health Care, especially for use in wound treatment applications.

According to the company of Gothenburg, Sweden, the improvements, among others, are achieved by providing a substrate of non-ionic nonwoven fibres, preferably a web, which are cross-linked by an agent having at least two groups capable of forming a hydrogen bond, such as hydroxyl groups, amino groups or sulfhydryl groups.

As US Patent 20230136758 demonstrates, the resulting fibre materials have improved tensile strength, in particular wet tensile strength, compared with fibre materials not treated with such an agent. The improvement in wet tensile strength can be, for instance, at least 15%, says Mölnlycke Health Care.

A “non-ionic” fibre is described as a fibre that is substantially not ionising in aqueous solution at a pH value of 7. The non-ionic fibre material can comprise, for example, polyvinyl alcohol (PVA), preferably cross-linked PVA, polysaccharides and/or polyurethane polymer with polyethylene glycol and/or polypropylene glycol functionalities, and/or copolymers of these.

The inventors suggest that the improved mechanical properties of a non-ionic fibre material that has been treated with an agent comprising two groups capable of forming a hydrogen bond is due to the formation of hydrogen bonds between the backbone of the polymer making up the fibre material and the hydrophilic groups of the agent. This mechanism is believed to contribute to improved properties, such as improved wet strength, gelling speed and preventing the product from drying out too quickly.

The fibre materials disclosed in the Patent could also be used in absorbent hygiene products, such as feminine sanitary products, diapers and absorbent pads, the company states.

See also: US Patent 20230136758, *Fiber materials with improved properties for use in wound treatment*.

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Atraumatic bandage impregnated with paraffin

An improved atraumatic wound dressing has been developed by several Russian inventors. The bandage described in Russian Patent RU0002794883 comprises a textile carrier impregnated with a hard paraffin composition.

The textile carrier can be a cellulosic and/or synthetic fibre material made into a woven, knitted or nonwoven material.

The paraffin has a density of 880–915 kg/m^3 and a melting point of more than 52–54°C, which prevents it melting at body temperature.

The paraffin composition includes esters of fatty acids and polyhydric alcohols, which are surfactants that inhibit the growth of paraffin crystals, thereby reducing the crystallisation rate of the paraffin composition. Further, such substances, acting as emulsifiers, prevent phase separation of the composition in the presence of a hydrophilic component.

The paraffin composition also includes tetradecyl stearyl stearate, which determines the plasticity of the paraffin composition, ensuring the mobility of the paraffin crystals relative to each other while maintaining the integrity of the paraffin layer.

The inventors note that coarse, cotton mesh dressings impregnated with soft white paraffin, such as petrolatum or mineral oil, can create an occlusal film that makes gas/air exchange difficult owing to the low softening temperature of the soft paraffin. In addition, phase separation of the composition can occur due to the incompatibility of water and paraffin.

Further, paraffin with a low density is quickly crystallised, so when using a textile carrier with a smaller pore size the pores can be closed with paraffin during impregnation, while fragmentation of the paraffin layer can occur due to the presence of water and lack of chemical affinity between the components of the composition.

The atraumatic bandage disclosed in the Patent is designed to overcome these disadvantages.

See also: Russian Patent RU0002794883, *Atraumatic wound bandage*.

Prostheses

Slowly resorbable synthetic hernia mesh

A slowly resorbable synthetic hernia mesh that is claimed to be cheaper and more efficacious compared with biological mesh for use in the repair of complicated hernias has been developed by researchers from the University of Nebraska Medical Center, Omaha, Nebraska, USA. The hernia mesh also provides incisional support in obese patients, who have a higher risk of hernia.

Disclosed in US Patent 20230130357, the multi-layer hernia mesh is broadly configurable and can be varied to have the desired tensile strength, thickness, mesh area and/or shape, rate of absorption and/or active agents delivered.

The mesh and/or its individual membranes/layers can be non-resorbable, partially resorbable or fully resorbable. For example, the addition of a non-resorbable polymer, such as polypropylene, within one or more membrane/layer can make the membrane partially absorbable with enduring tensile strength.

In one example, the multi-layer hernia mesh comprises a first layer comprising a two-dimensional (2D), non-expanded nanofibre membrane or mat and a three-dimensional (3D), expanded nanofibre membrane or structure.

The 3D expanded nanofibre membranes can be:

- porous scaffolds;
- inverse opal scaffolds (e.g., porous structures with an ordered array of uniform pores with dimensions on the nano- and micrometre scale);
- porous or expanded scaffolds generated by supercritical carbon dioxide fluid;
- porous or expanded scaffolds generated by gas generation;
- nanofibre aerogels;
- porous scaffolds generated by freeze drying;
- porous scaffolds generated by 3D printing;
- porous scaffolds generated by phase separation;
- porous scaffolds generated by using a sacrificial template.

The multi-layer hernia mesh can further comprise a strengthening or support layer (e.g., an approved, non-resorbable synthetic material), which can be placed between the 2D nanofibre membrane and the 3D expanded nanofibre membrane.

The nanofibres and nanofibre membranes can comprise, for instance, polycaprolactone and polylactide in a 1:1 ratio, and can be fabricated in particular by electrospinning, as well as by weaving or knitting.

Figure 4 depicts a cross-section of the human abdomen, showing the intraperitoneal placement of the hernia mesh (IPOM). The mesh is placed directly underneath the abdominal wall (AW) to buttress the surgical incision (SI), with viscera (V) directly underneath (SSC = skin and subcutaneous tissue).

The synthetic hernia mesh described in the Patent can be used to induce, improve or enhance hernia healing and/or prevent and/or inhibit hernia formation, according to the researchers. In particular, the mesh can be used for the management of hernia disease in obese patients.

See also: US Patent 20230130357, *Multi-layer hernia meshes and methods of manufacture and use thereof*.

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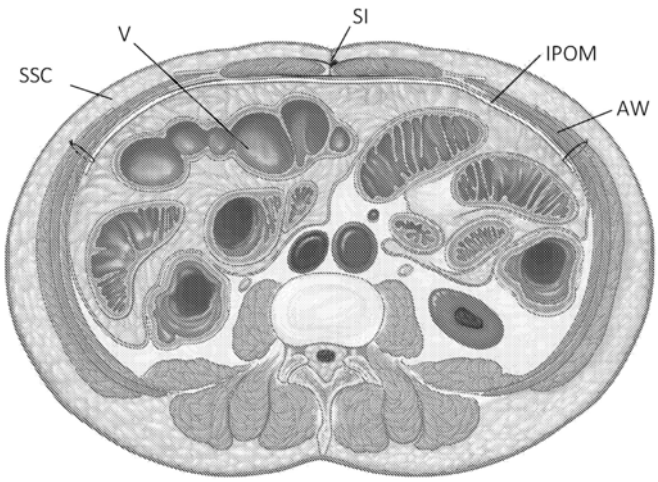

Figure 4: Schematic diagram of a cross-section of the human abdomen, showing the intraperitoneal placement of the hernia mesh.

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Compression therapy

Artificial muscle massage garment

An improved artificial muscle massage garment for the treatment of lymphoedema has been developed by Essity Hygiene and Health.

According to the company of Mölndal, Sweden, the device described in International Patent WO2023078562 is designed to overcome the disadvantages of existing massage garments, which can be bulky, heavy, expensive and limit the range of activities that the user can perform during treatment.

Essity's garment comprises one or more bands (200) that are placed around a limb of a user and one or more artificial muscles that surround part of the limb and apply a compression force to the limb.

Each artificial muscle comprises one or more coiled elements (203), such as a spring made of a shape-memory alloy that contracts when heated and acts as a means for applying energy to cause the artificial muscles to be heated.

Each band comprises a textile fabric (210) made from a heat-insulating material in or on which the coiled element is located. For example, the coiled element can be embedded or integrated in the fabric, such as woven into the fabric or included in channels in the fabric or laid on a surface of the fabric and attached to it by adhesive or other attachment means.

The coiled element can be a wire-like element that is twisted or shaped into a helical form, such as for example a twisted filament, fibre or wire or a bundle of filaments, fibres or wires, or a helical spring.

The inventors found that coiled elements that contract axially when heated, such as coiled elements in a shape-memory material or exhibiting a shape-memory effect when heated as a result of applied energy, such as resistive heating by applying electric energy, can be used effectively as artificial muscles in massage garments.

Providing the coiled element in or on the fabric avoids such problems as heat transfer from the coiled elements onto the user's skin and/or friction when the artificial muscles contract and expand.

Further, the fabric acts as a support structure for positioning the coiled element and can further minimise or eliminate direct contact between the coiled element and the user's skin.

The fibres of the fabric are preferably made of a heat and/or electrically insulating thermoplastic material, such as polytetrafluoroethylene, polyamides, polyesters, polyaramids or combinations of these.

The fabric can be a woven, knitted, nonwoven or other fabric, in which the coiled elements can be embedded or integrated, or which carries the coiled elements on a surface

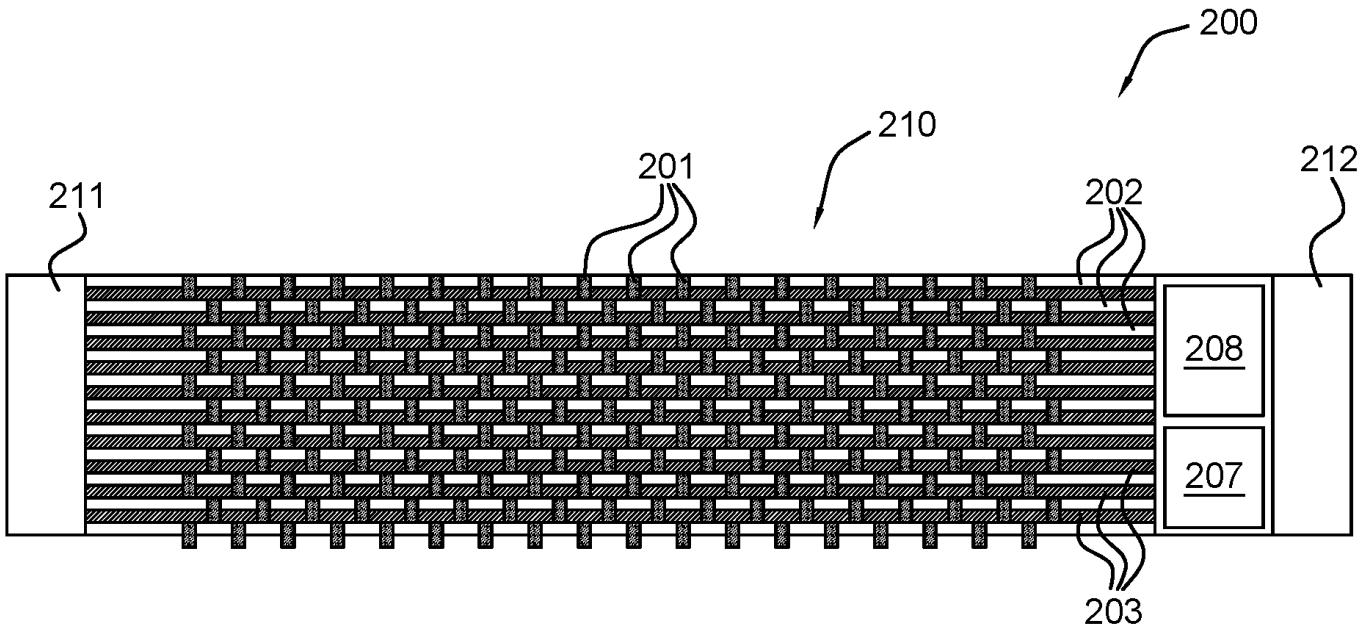

Figure 5: Top view of a band of an artificial muscle massage garment developed by Essity.

that in use is directed away from the user's skin.

The flexibility or elasticity of the fabric also allows the coiled element to contract and expand more freely when the energy is applied.

Figure 5 shows a band in a woven fabric in which the coiled elements are provided as first warp yarns of the fabric, which alternate with second warp yarns (202) in the heat and/or electrically insulating material.

The weft yarns (201) of the woven fabric are also preferably made of heat and/or electrically insulating material, preferably the same material as the second warp yarns.

The band is shown with end sections (211, 212) that are provided with complementary portions of a hook-and-loop type fastener.

The band can be stretchable such that, when placed on the limb, a baseline pressure is applied. The coiled elements are stretched along with the band when the band is placed on the limb and, when activated, apply a compression force on top of the baseline pressure.

The band can further comprise cover layers (not shown) on the inside (limb-facing side) and/or the outside (side facing away from the limb) of the band, for example as a protective cover, as further heat and/or electrical insulation and to reduce friction between the user's skin and the fabric in or on which the coiled element(s) are provided.

The band also has an individual control unit (207) and power source (208), such as a rechargeable battery, located at one end of the woven fabric.

Coiled filaments for use as artificial muscles can be made from suitable primary polymer yarns, such as Shieldex 4-ply, Dyneema DM20, Dyneema SK72, Dyneema SK78, SpiderWire Stealth, SpiderWire UltraCast, Berkley Nanofil and Berkley Fireline.

Electrically conductive silver-coated polyamide yarns, such as Shieldex, can be incorporated alongside the primary polymer yarns before the yarns are coiled to allow electrical heating during use.

The coiled yarn is heat treated under tension in an oven (e.g., 120°C for two hours) to set the shape of the polymer coiled muscle and to prevent the yarn from untwisting.

See also: International Patent WO2023078562, *Artificial muscle massage garment with coiled elements in or on textile fabric*.

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Knitted robotic textile for hand oedema patients

Researchers at Cornell University in Ithaca, New York, USA, have developed a knitted wearable tool to treat hand oedema – swelling caused by excess fluid accumulation from injury or disease – that can be personalised and used in the comfort of one's own home.

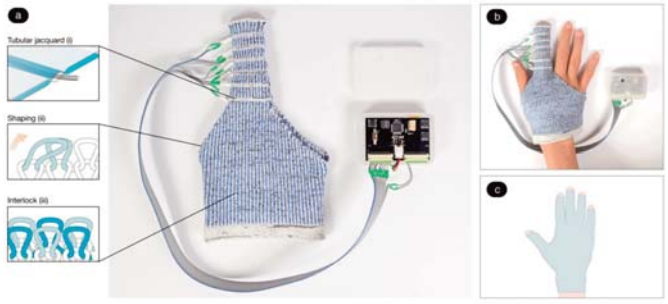
Currently, the best treatment for hand oedema is manual oedema massage (MEM) by a trained therapist, but access to care and cost can make the procedure prohibitive.

Cindy (Hsin-Liu) Kao, assistant professor of human-centred design and director of the Hybrid Body Lab at Cornell University, and her team worked with physicians at Weill Cornell Medicine and therapists at the Cayuga Medical Center Department of Physical Therapy to devise a knitted wearable technology, called KnitDema, that can gently massage the swollen area through sequential compression by small robotic actuators.

They chose to focus on hand oedema, particularly swelling of the fingers, "because it is a condition that affects a lot of people and can have significant impact to activities of daily living, since finger mobility is indispensable in our day-to-day lives," said Kao.

Heather (Jin Hee) Kim, a doctoral student in human-centred design and a Hybrid Body Lab member, and Kao devised a knitted robotic textile to be put over a single finger, with thread-like shape-memory alloy (SMA) springs woven into the knitted material. The springs are activated by a small, printed circuit board and compress sequentially to

KnitDema consists of a machine-knitted semi-glove and hardware to compress oedematous hands sequentially. The device covers the index finger and uses embedded shape-memory alloy bands to mobilise oedema fluid from the fingertip to the base. Image: Hybrid Body Lab, Cornell University



(a) KnitDema system in which the finger sleeve is knitted with a combination of (i) tubular jacquard, (ii) shaping and (iii) interlock structure. The tubular structure creates "channels" to incorporate shape-memory alloy springs. The substrate also uses a shaping structure to conform the substrate to the rest of the fingers. (b) KnitDema finger sleeve device worn on a hand. (c) Future implementation of a full-hand KnitDema device. Image: Hybrid Body Lab, Cornell University

mobilise fluid out of the swollen area.

The duration and intensity of SMA spring compression is adjustable depending on the needs of the individual patient. The transition temperature at which the springs contract was 45°C, which participants tolerated without discomfort, according to a paper presented at the ACM CHI '23 Conference on Human Factors in Computing Systems held in Hamburg, Germany, in April.

The researchers first tested KnitDema on a simulated finger (a saturated sponge encapsulated in silicone). They designed the device to be comfortable to wear and quiet, with a more evenly dispersed compression around the swollen area compared with MEM treatment.

In addition to the active compression, the device itself is made with a stretchable yarn – with hollow pockets for the actuators built in – that offers a tight fit and passive compression even when the actuators are not on.

"We experimented with a lot of different types of yarn and novel knit structures to identify the unique combination that would be effectively compressing but not uncomfortable," said Kao.

She sees KnitDema, and potential other devices using this technology, as a "personalised rehabilitation device", a term coined by the team as something that could be prescribed to an outpatient, as would a medication.

"Instead of having to schedule a hard-to-get visit with a therapist for MEM, we envision this as something that people could take home with them," Kao said. "They would go to their rehabilitation doctor and their occupational or physical therapist once, and at that session they would be able to configure the right amount of compression for daily use, then adjust as necessary."

Dr Joan Stilling, assistant professor of clinical rehabilitation medicine at Weill Cornell Medicine, added: "It also allows for use any time that is convenient for the patient, often when symptoms are worst for the individual.

"In addition, each device is personalised for each person through the digital machine knitting, allowing for a customised fit, which is not readily available through standard treatment options on the market."

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Printing

Functional textiles: an alternative to antibiotics

A PhD student at the University of Borås, Sweden, has conducted research to develop more resource-efficient methods for producing functional textiles using digital ink-jet printing.

In his doctoral thesis, "Enzyme printed fabrics: bio-functionalisation of synthetic textiles by digital inkjet printing", Tuser Biswas has shown that it is possible to print enzymes on textiles.

Enzymes are proteins that function as catalysts in the body, as they set chemical processes in motion without themselves changing. They could, for example, be used in medical textiles with antimicrobial properties or to measure biological or chemical reactions.

"Ever since the industrial revolution, our society has used an abundance of synthetic and harsh chemical," said Biswas. "Our research works to replace these chemicals

Tuser Biswas. Image: Swedish School of Textiles, University of Borås

Image: University of Borås

with environmentally friendly and bio-based materials."

Promising results

Developing a good enzyme ink was not easy and it took a number of attempts before he finally produced successful results. He explained that the most important result was to show how a printed enzyme could bind another enzyme to the surface of a fabric.

Although the activity of the enzymes decreased by 20–30% after printing, the results are still promising for future applications. The work has also provided new knowledge on many fundamental questions about printing biomaterials on fabric.

"Before starting the project, we found several related studies that focused on producing a finished product," Biswas said. "But we wanted to study the fundamental challenges of this subject – and now we know how to make it work."

He is now seeking funding to continue researching the subject and has so far received a grant from the Sjuhärad Savings Bank Foundation.

Biswas hopes that continued research in textile technology can provide alternatives to the use of antibiotics, which has resulted in increasing antibiotic resistance worldwide.

"Instead of treating the patient with a course of antibiotics, one can act preventively and more effectively by damaging the bacteria on the surface where they start to grow," he said.

"In a wound dressing, for example, nanoparticle-based antimicrobials can reduce growth effectively. It is possible as nanoparticles can interact better with the bacterial membrane and reach the target more easily than conventional antimicrobials."

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Hygiene

Zero-waste production of menstrual underwear

Kelheim Fibres and Santoni have developed sustainable menstrual underwear based on advanced machine technology and high-performance viscose fibres.

The menstrual garment consists of a soft outer layer and an inlay made from wood-based fibres, combining comfort and functionality.

The outer layer is produced on Santoni SM8-TOP2V or SM4-TL2 circular knitting machines, which are said to significantly reduce the amount of cutting waste or even allow production with zero waste.

The Santoni XT-Machine, originally developed for the footwear market, is used for the functional inlay of the garment and allows for different layers to be produced with different yarns and knitting structures.

This enables all three functions of the inlay – absorption and distribution layer, absorbent core and backing layer – to be knitted in a single tube, thereby reducing production time and costs and enabling zero-waste production.

In the inlay, Kelheim's wood-based speciality fibres, such as trilobal Galaxy or the hollow Bramante fibre, replace synthetic materials.

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Indian launch for slim absorbent underpants

Friends, the flagship brand of Indian disposable hygiene product manufacturer Nobel Hygiene, has launched what is claimed to be the country's first "slim" disposable absorbent

Kamal Kumar Johari, managing director and founder of Nobel Hygiene with Friends UltraThinz. Image: Nobel Hygiene

underpants.

Friends UltraThinz is designed specifically for younger consumers who suffer from light incontinence owing to conditions such as obesity, prostate issues and postpartum incontinence. It is also effective for heavy blood flow post-pregnancy, menopause and endometriosis.

As men's and women's bodies and the types of incontinence they face are different, and require differentiated solutions, Friends UltraThinz is available in two variants: a peach-coloured dry pant for women and a grey-coloured dry pant for men.

The research and development team at Friends observed that the age of incidence of incontinence is decreasing, with younger customers facing milder forms of incontinence and shying away from using "bulky" diapers that may show up under their clothing.

Friends UltraThinz is designed to be a sleeker, more-functional product that is absorbent, disposable and provides an invisible, "bulge-free" fit under even the tightest clothing.

Apart from the sleeker design, UltraThinz is said to retain the high-quality absorption mechanism, comfortable cottony fit and antibacterial and odour-lock properties that its parent brand is known for.

The new underpants product is available in chemists, supermarkets and women's speciality stores, and comes in three sizes: medium, large and extra-large, priced from INR399 (US$4.85).

Part of the proceeds from each pack of UltraThinz sold will be donated to the Agewell Foundation, the brand's corporate social responsibility partner.

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Personal care

Microbiome-friendly seal for textiles

A survey carried out in March by MyMicrobiome showed that 93% of all surveyed consumers are interested in wearing textiles that are friendly to their skin microbiome.

While the influence of personal care products on microbial health is increasingly being recognised, the effect of various textiles that touch the sensitive skin microbiome on a daily basis is still unmonitored and rarely taken into consideration.

Since 2019, MyMicrobiome co-founder and chief executive officer Dr Kristin Neumann and her team have certified more than 350 personal-care products of more than 80 brands for their microbiome friendliness.

The Liechtenstein-based company has now introduced a new seal that tests textiles that come into contact with the face, body, scalp, vaginal, foot, oral, nasal and infant skin microbiome to assess their impact on the respective microbial ecosystem.

"For the first time, we can now label and certify textiles like jeans, functional apparel, diapers, tampons, sheet masks and other hygienic products that treat the skin's microbiome gently," said Neumann. "If they preserve microbial diversity and do not influence the growth of microbes, they are awarded the 'Microbiome-friendly' seal."

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microbiome
The community of micro-organisms, both helpful and potentially harmful, that can usually be found living together in any given habitat.

Divestment of Mexican business completed

Personal care products supplier Ontex Group has completed the divestment of its Mexican business activities to Softys for a total net amount of €265m

Softys is a personal hygiene company with operations across Latin America and a wholly-owned subsidiary of Empresas CMPC, headquartered in Chile.

The transaction includes Ontex's manufacturing facility in Puebla, Mexico, and its branded business in Mexico, as well as related exports to certain regional markets. The business employs around 1,000 blue-collar workers and 350 white-collar workers.

Ontex's manufacturing facility in Tijuana, Mexico, will remain with Ontex and will form an integral part of Ontex's North American operations and supply chain footprint.

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Investment in sustainable baby diaper production

Austria-based technology group Andritz has commissioned a converting line for manufacturing baby diapers at Naturopera's new plant in Bully Les Mines, France.

The eXcelle converting line from Andritz Diatec features technology to produce both traditional and bio-based baby diapers, supporting Naturopera in its efforts to become a leading producer of sustainable diapers.

Naturopera, which manufactures baby care, femcare and household products, is preparing to produce diapers made of 90% bio-based raw materials in a diaper concept developed by the two companies.

It replaces the traditional spunbond and meltblown nonwoven layers with spunlace nonwovens mostly made of natural fibres, with a prototype of the 90% bio-based diaper recently produced at Bully Les Mines.

The Andritz converting machine operating at Naturopera is flexible, taking just a few settings to switch to the production of bio-based diapers. It is designed for a multiple-size process, features an operator-friendly interface and has a production speed of 800 ppm.

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FET strengthens technical team

Fibre Extrusion Technology (FET) of Gildersome, Leeds, UK, has appointed Dr Jonny Hunter as research and development (R&D) manager.

Hunter holds a master's degree in medicinal and biological chemistry and a PhD in sustainable chemistry and has more than 10 years' R&D experience in industry, in particular, medical devices, encompassing wound care, the manufacturing process and the regulatory environment.

FET manufactures extrusion equipment for a wide range of textile material applications. A significant market for the company's melt-spinning equipment is medical devices.

Mark Smith, the previous R&D manager, is taking a short sabbatical and will be returning in a more strategic role as FET's director of technology.

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Fibre Extrusion Technology's director of technology, Mark Smith (left) and new R&D manager, Dr Jonny Hunter. Image: FET

DIARY OF EVENTS

September 2023

13-15 September 2023
Dornbirn Global Fiber Congress
Dornbirn, Austria
Contact: Austrian Fibers Institute
Tel: +43 664 621 6703
Email: office@dornbirn-gfc.com
www.dornbirn-gfc.com

November 2023

13-16 November 2023
Hygienix
New Orleans, Louisiana, USA
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Email: info@inda.org
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April 2024

9-12 April 2024
Techtextil
Frankfurt am Main, Germany
Contact: Messe Frankfurt
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Email: techtextil@messefrankfurt.com
www.techtextil.com

April 2026

21-24 April 2026
Index
Geneva, Switzerland
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Tel: +41 22 761 1111
Email: index@palexpo.ch
www.indexnonwovens.com

Submit your event listing to: The Editor, Medical Textiles. Email: gfisher@textilemedia.com

Event information may be out of date and subject to change. Please confirm details with event organisers

OTHER PUBLICATIONS FROM TMS

MONTHLY NEWSLETTERS

Smart Textiles and Wearables

Formerly *Smart Textiles and Nanotechnology*, this publication has been renamed to better reflect the progress being made with the IoT, continuous miniaturisation, 3D printing and soft materials

MobileTex

A monthly newsletter providing commercial news, product, and marketing and technical information of the global transport textiles industry, including the automotive, aerospace, rail and marine sectors. The publication is aimed at producers and users of fibres, yarns, fabrics and end-products used in automotive and other transportation textiles

Textiles Eastern Europe

A monthly newsletter providing commercial news, information and business opportunities of the textile and clothing industries in the emerging markets of Central and Eastern Europe and the former Soviet Union. Read by top management and global decision-makers with an interest in capitalising on and investing in the economic regeneration of this rapidly developing region

Textiles South East Asia

A monthly newsletter providing hard-to-find commercial news, information and business opportunities of the textile and clothing industries in South East Asia. This developing region offers new prospects for marketing products and services, as well as sourcing opportunities, in Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam

MARKET REPORTS

Personal Protection Textiles (2nd edition)

This revised edition outlines the global market for personal protection clothing in the industrial, workwear and private sectors, and details legislation, regulations and standards for their manufacture and use

Automotive Nonwovens (3rd edition)

This updated report examines the structure of the automotive nonwovens sector, including profiles of key Tier 1 and Tier 2 players that use these rapidly developing materials

Automotive Textiles (5th edition)

This revised edition analyses the fast-moving global automotive textiles industry and describes the wide-ranging use of textile materials in vehicles

Automotive Composites (2nd edition)

This market report reviews the current use of composites in the automotive sector and assesses how far these materials are from being used in mass production

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