SMART TEXTILES & WEARABLES

At the interface of soft materials and electronics

January 2024 | Editor: Geoff Fisher

SMART TEXTILES

Prototype smart glove helps improve stroke rehabilitation

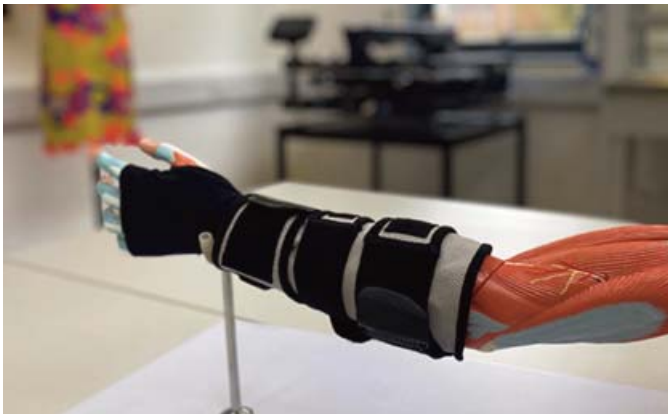
An electronic glove that enables movement in the paralysed hand of stroke survivors to support their rehabilitation has been invented by a team from the UK's University of Southampton.

The glove has electrodes printed on the sleeve that make contact with the skin. The electrodes send electronic impulses to stimulate the nerves and muscles to produce an artificial movement, which enables stroke survivors to achieve movement in their weak side, helping them to regain muscle strength and function.

The glove was designed by Kai Yang, Professor of E-textiles in Healthcare, and her team based at the university's Winchester School of Art (WSA).

"I wanted to develop something easy for stroke survivors to use at home," Yang explained. "People who have suffered a stroke get fatigued easily, so engaging in long rehabilitation sessions is very challenging. This glove enables them to work on their rehabilitation in small blocks of time when it suits them. With stroke rehabilitation, the more you practice movement, the more you regain muscle strength and mobility."

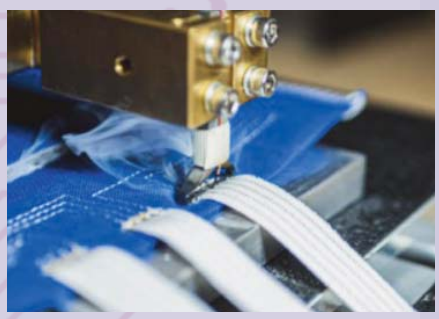
The prototype glove was developed at WSA using industrial knitting machines. The electrodes are printed inside the sleeve and connected to an electronic control unit, allowing the user to vary the level of stimulation as required.

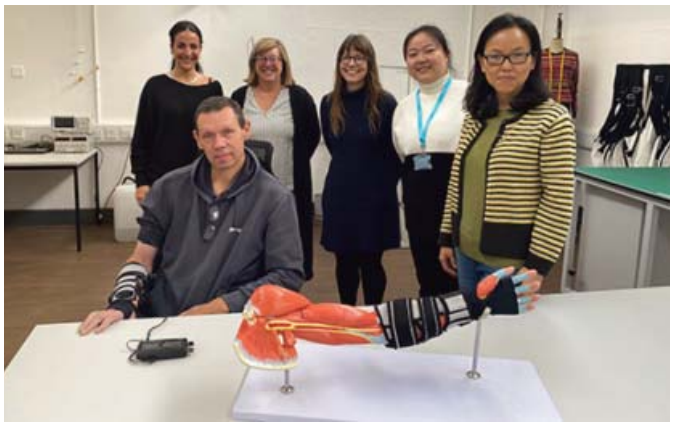


The stroke glove prototype on a laboratory model. Photo: University of Southampton

To develop the glove Yang worked with Different Strokes Southampton, a charity run by stroke survivors for stroke survivors.

Highlights this month





Stroke survivor Dave Lea (seated) with his wife Sarah (standing, second from left) and the E-textiles in Healthcare team, headed by Professor Kai Yang (right). Photo: University of Southampton

Ranj Parmar, group co-ordinator for Different Strokes Southampton and a stroke survivor himself, said: "The benefits of the stroke rehabilitation sleeve are extremely impactful. It allows stroke survivors to be able to continue their rehabilitation many weeks and months after their stroke. It enables a stroke survivor to open their affected hand and when performed repeatedly it should enable the opening and closing of the hand more easily."

Yang is now looking to refine the design of the prototype glove by working with more stroke survivors, and then conduct a home usability test with stroke survivors using the glove multiple times every day. Following this, she intends to seek regulatory approval and then work with a manufacturer to scale-up the production of the glove.

Professor Kai Yang with Sarah and Dave Lea, using the stroke glove. Photo: University of Southampton

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SMART TEXTILES

Textiles that record audio

SRI International, North Carolina State University and textile producer International Fabric Machines are working to incorporate a piezoelectric material into a fabric that acts like a microphone – a textile that can record audio – under a contract from the USA's Intelligence Advanced Research Projects Activity (IARPA).

The project – Smart Electrically Powered and Networked Textile Systems (Smart ePants) – aims to transform piezoelectric materials, which generate electricity when deformed, and lithium-ion batteries into yarns and weaving them into fabrics with audio-recording capabilities.

Sound waves hitting the fabric stretch the piezoelectric threads, resulting in an electric signal that can be recorded and later replayed.

The research team will aim to seamlessly integrate the sensor, along with its support electronics, into a textile that closely resembles the ones used in off-the-shelf clothing.

Eventually, the team hopes to fashion a whole garment – a shirt, pair of pants, socks and underwear – that records sound. (IARPA refers to these garments as primary clothing.)

The team must also develop and integrate similar thread-like technologies to power the system, store data, turn the system on and off, and notify the user that the system is engaged, which means developing similar thread-like lithium-ion batteries.

The garment will also have integrated memory, controls and haptic notification systems, although these will have other, non-thread-like forms, as well as all the necessary wires and interconnects to pull it all together into a fabric that looks and feels natural.

For multi-use garments, the resulting fabric must be

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Examples of decorative woven textiles used as inspiration for incorporating active fibres. Photo: Daniel Weispfenning/NCSU

resilient enough to be twisted, folded and washed repeatedly.

The research team also includes New York-based fashion designer Kenneth D. King who will give creative inputs.

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SMART TEXTILES

Yarn-thread technology comprises five fibres

Sweden-based Transforming Textiles has introduced a pioneering technology that adds sensors to fabric to provide real-time health metrics to a mobile device.

Sense-Tex is designed to prioritise environmental awareness through its five-fibre yarn-thread structure, incorporating two conductors – silver and zinc – and three natural fibres – ramie, soybean and SeaCell from seaweed – to produce a health-enhancing conductive fabric produced without adding chemicals.

Sara Rosberg, founder and chief executive officer, collaborated with space engineer Marcelo Boldt in 2021 and production and supply chain manager Tahir Haytoglu in 2022. Together they designed the technology that combines safety, fashion and sustainability.

Image: Transforming Textiles

Now based in Lund, Sweden, Sense-Tex was a top 10 space-tech finalist in the European Space Agency's Nordic Launch programme in 2022.

Sense-Tex is now formalising its presence in the fashion world with a showroom in Milan, Italy. The technology will also be part of Milan Fashion Week 2024 with Transforming Textiles' fashion brand Modality, which makes fashion garments out of Sense-Tex fabric.

Future plans include building a new smart recycling factory that mechanically separates the fibres and making Sense-Tex 100% circular.

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SMART FIBRES

Conductive cotton-based fibre for smart textiles

Researchers at Washington State University (WSU) have developed a fibre that is said to offer the flexibility of cotton and the electric conductivity of a polymer, which could have a range of applications in the smart textiles sector such as for wearable e-textiles.

In tests, the researchers used polyaniline, a synthetic polymer with conductive properties already used in applications such as printed circuit board manufacturing.

They tested the fibres with a system that powered a light-emitting diode and another that sensed ammonia gas, detailing their findings in *Carbohydrate Polymers*.

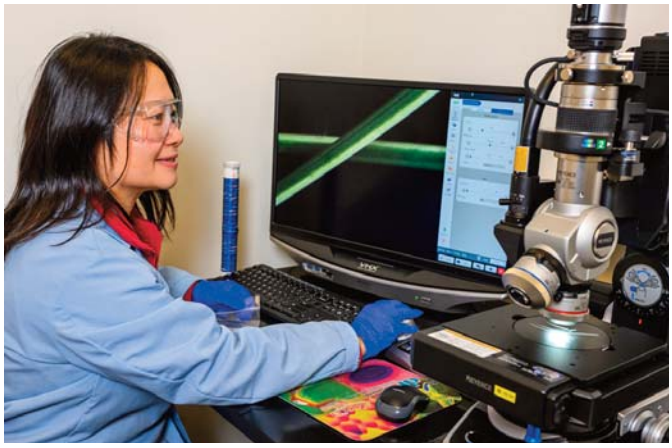
"We have one fibre in two sections. One section is the conventional cotton: flexible and strong enough for everyday use, and the other side is the conductive material," said textile researcher Hang Liu. "The cotton can support the conductive material, which can provide the needed function."

While more development is needed, the idea is to integrate fibres like these into apparel as sensor patches with flexible circuits, which could be part of uniforms for firefighters, soldiers or workers who handle chemicals to detect for hazardous exposures. Other applications include health monitoring or exercise shirts that can do more than current fitness monitors.

In this study, the WSU team worked to overcome the challenges of mixing the conductive polymer with cotton cellulose. While intrinsically conductive, polyaniline is brittle and by itself cannot be made into a fibre for textiles.

To solve this problem, the researchers dissolved cotton cellulose from recycled T-shirts into a solution and the conductive polymer into another separate solution. These two solutions were then merged together side-by-side, and the material was extruded to make one fibre.

The result showed good interfacial bonding, which means that the molecules from the different materials stay together through stretching and bending. However, achieving the right



Researcher Hang Liu examines fibre samples developed in her laboratory at Washington State University. Photo: Dean Hare/WSU Photo Services

mixture at the interface of cotton cellulose and polyaniline was a delicate balance, Liu said.

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WEARABLES

Sewing, embroidery and lasers create sensors

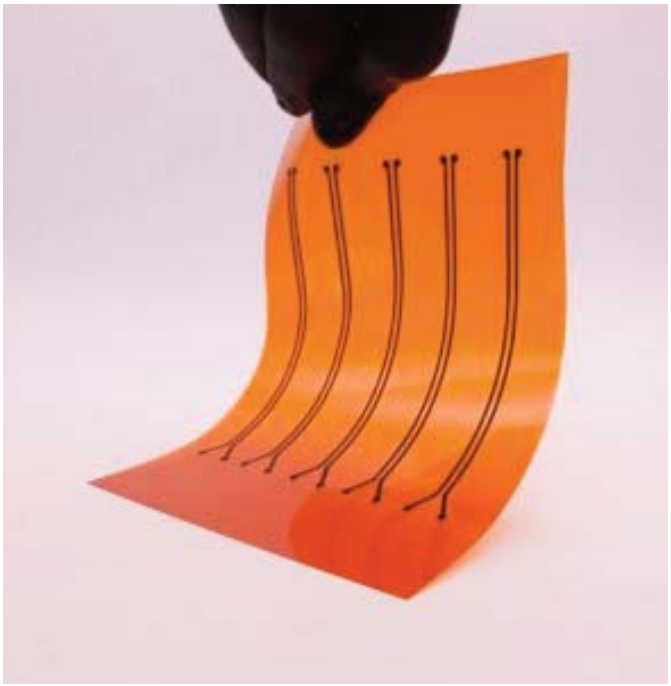
Researchers in the Department of Biomedical Engineering at the University of Southern California are using embroidery and lasers to create affordable, cutting-edge sensors for wearables and personalised healthcare.

The research team at the university's Laboratory for the Design of Medical and Analytical Devices (MAD Lab) recently acquired a Husqvarna Viking Designer Ruby 90 deluxe sewing and embroidery machine – a software-enabled machine used in fashion settings for complex embroidering and monogramming applications.

The team is adapting the technology to create custom flexible sensors for wearables and other purposes. The aim is to reduce the cost and inefficiency of medical testing and monitoring, making it more accessible for patients with chronic diseases and those who do not have easy access to hospitals.

Assistant Professor of Biomedical Engineering Maral Mousavi explained that traditional medical testing has many inefficiencies. Patients must make multiple trips to a hospital or laboratory, along with follow-up appointments with the physician to discuss results and treatment options – a process that does not work well for patients with chronic illnesses requiring regular daily monitoring.

To create simple and accessible sensors that are worn on the body for continuous monitoring, the laboratory has harnessed innovative and ubiquitous materials such as yarn, thread, paper and even nail polish to create cheap and easy-to-scale sensors.



Laser-engraved sensors created in the MAD Lab. Photo: Abdulraham Alshami and Victor Ong/USC

The MAD Lab uses sewing, embroidery and lasers to create sensors and wearables. Photo: Greta Harrison/USC

The new Viking sewing and embroidery machine will enable the team to prototype soft and flexible wearables using custom embroidery techniques with conductive threads to create inbuilt sensors. The sensors can measure a range of health and disease biomarkers in human body fluids, such as sweat, saliva or blood.

Melissa Banks, a PhD student in the MAD Lab, said the advantage of harnessing sewing and embroidery in the laboratory's sensor design is the capacity the format offered for customisation.

The Husqvarna machine allows the team to use conductive threads and fabrics created by materials scientists to form electrode patterns in infinite designs, with the machine's software allowing intricate control of the shape and size of the electrode.

The laboratory also uses a carbon dioxide laser engraver to create electrochemical sensors out of affordable polymer

films. Mousavi's team harnesses the laser to create a burn pattern of conductive carbon in a simple polymer sheet, which is then able to conduct electric signals.

She said the process is environmentally friendly, as it does not require the destructive chemicals or solvents usually used for processing and masking electrodes.

The process is also much cheaper: where traditionally manufactured electrodes would cost around US$7 each, the MAD Lab can quickly manufacture multiple electrodes on a single piece of polymer film at a cost of cents per electrode.

Mousavi said the resulting sensors have applications that can target anything from soil and plant health to medical monitoring.

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E-TEXTILES

Integrating electronic components into textiles

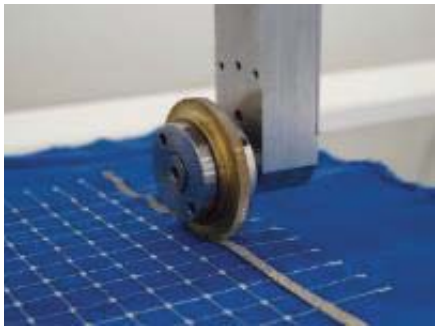
High-quality, stable, reliable and durable electrical contact is essential for the success of electronic textiles (e-textiles), which must meet the requirements of both textiles and electronics.

In general, textiles are soft, lightweight, breathable, flexible, shapeable in all three dimensions, convenient, washable and have a low thermal stress of up to 200°C.

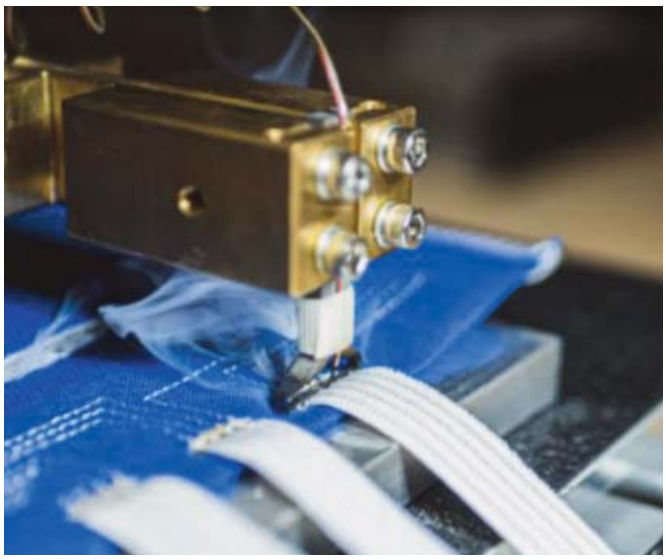
In contrast, electronics are generally hard, solid, usually inflexible, dimensionally stable, susceptible to moisture, have a relatively higher weight with higher temperatures (more than 230°C) required for processing and conventional assembly.

"After integrating electronics into textiles it is necessary to preserve as many textile properties as possible," said Dr Radek Soukop of the Department of Materials and Technology, Faculty of Electrical Engineering, University of West Bohemia, Pilsen, Czech Republic.

"Therefore it is necessary to use miniaturised electronics and new contacting, encapsulation and integration technologies. Simply adapting conventional electronics technology is not sufficient."



Roll-to-roll thermoplastic ultrasonic welding conductive ribbons on embroidered testing pattern. Photo: University of West Bohemia



Hot-bar resistance welding is a prospective technology for non-detachable interconnections in e-textiles. Photo: University of West Bohemia

Speaking at the E-Textiles 2023 conference held in November in Ghent, Belgium, Soukop said e-textile garments should provide:

- user comfort and convenience;
- low weight with small-size electronics;
- high maintenance resistance (i.e., automatic washing and drying);
- high mechanical resistance;
- breathability;
- compliance with norms and standards;
- resistance to harsh environments (for protective clothing).

However, the challenges for e-textiles include:

- energy harvesting systems (e.g., photovoltaics, piezoelectric systems, etc.) that suffer from low levels of power generation;
- most industrial electronics manufacturing technologies are not compatible with textile manufacturing, so it is necessary to come up with new technologies;
- many textile products suffer from a lack of resistance to washing.

In his keynote presentation, Soukop explained that newly developed interconnection technologies should be scalable and compatible with conventional textile manufacturing processes.

For example, thermoplastic ultrasonic welding and hot-bar resistance welding are possible technologies for non-detachable interconnections in e-textiles.

Meanwhile, thermal compression contacting technology with a three-dimensional printed thermoplastic housing is suitable for use in high-mix, low-volume production, such as for the direct integration of electrical elements on conductive ribbons and flat textiles.

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E-TEXTILES

From heated clothing to monitoring astronauts: what's next for e-textiles?

From blankets to towels to clothing to upholstery, humans are in contact with textiles for almost all their lives. Textiles, used for warmth, comfort and aesthetics, can be combined with electronics to gain exciting new functionalities.

These electronic textiles (e-textiles) have come a long way from heated blankets commercialised in the 1960s and 70s and have advanced to include state-of-the-art smart shirts that monitor astronauts aboard the International Space Station (ISS) today.

However, the road has not always been smooth for e-textiles, and companies in the field have yet to find an application that matches the success of textile heating, says Dr Tess Skyrme, senior technology analyst at IDTechEx.

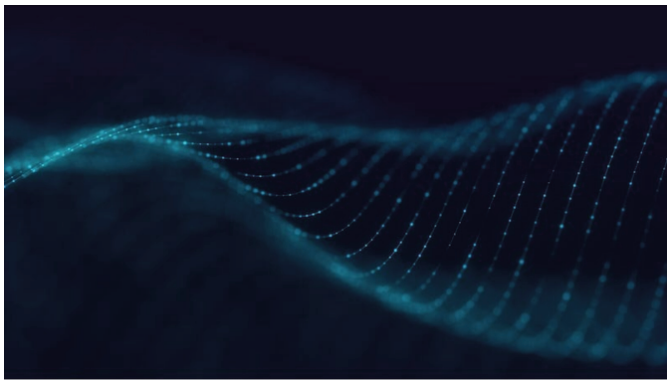

Image: IDTechEx

New ways of keeping warm

"Today, heating is still the most successful application of e-textiles, accounting for more than 80% of the market value in 2023," she notes. "From motorcycle riders to outdoor workers to people enjoying snow sports, heated clothing provides much-needed warmth in cold winter conditions."

Heated blankets have also been popular for several decades, and interest has been spurred on in recent years by drastic rises in energy costs.

The success of heating as an application of e-textiles is due to the technology's ability to provide local heating to the person in a comfortable form factor.

Compared with alternatives, such as heating the entire room (costly), to hand warmers (only heats a small area), to simply wearing more clothing (bulky), heated textiles leverage the strengths of both textiles and electronics.

While power supply remains a key problem in this application, with users having to either carry a rechargeable battery or be tethered to a power source, the increasing availability of portable USB power banks is helping to drive heated apparel to consumers. IDTechEx forecasts a steady growth in heated textile applications to 2033, with a compound annual growth rate of 4.5%.

Biometric sensors

One of the applications of e-textiles that has seen the most interest, advances and promise over the past decade is biometric sensing. The integration of various sensors into apparel can enable the monitoring of key vital signs, including heart rate, respiration rate and body temperature.

Investor interest in sports and fitness applications for e-textiles rose through the early 2010s, but several issues, including cost and washability, have since hindered major sporting goods companies from commercialising the technology for the mass market.

While smart athletic shirts can monitor key vitals for sports applications, alternative technologies, such as smartwatches, have since caught up and are able to replicate most of the biometric sensing required. Not only do smartwatches have more functions than a smart shirt, but they also have greater reusability and offer greater flexibility.

Companies are instead looking to monitoring vital signs for applications where the information is critical, from healthcare through to worker safety.

"For example, electrodes embedded within smart vests can monitor the vitals and heat stress of workers in extreme environments," says Skyrme.

"This is critical data for mission control which needs to know that the wearer's cognitive abilities are intact for high-stress situations such as firefighting. Of course, the smart shirts can also be applied to studying how the human body responds to extreme situations, such as astronauts on the ISS."

The typical challenges that smart garments for consumers face, such as having to wear the same outfit every day or high unit costs, become less important when the garment is part of a uniform, or when the data is critical and cannot be replicated as easily or as accurately by alternatives.

Smart insoles

Another factor where e-textiles can truly leverage their unique strengths of comfort, softness and function are smart insoles, which are applied for both gait monitoring and diabetes management applications.

While other wearables can monitor gait, pressure-sensing insoles measure a person's motion symmetry and force distribution, allowing medical professionals to assess progress in a person's recovery from injuries that hinder mobility.

When combined with temperature sensors, these smart insoles utilise points of elevated pressure and/or temperature to warn doctors of potential ulcer formation.

Remote monitoring of ulcers can help people with diabetes, who are at risk for developing non-healing ulcers that eventually result in amputation. However, while the market for diabetes management technologies will be worth more than US$30bn by 2033, it is unlikely that smart insoles will capture much of this market, leaving e-textiles manufacturers continuing their hunt for a runaway success.

"To deliver a compelling product, companies must leverage both the advantages of textiles and the function of electronics through textiles," Skyrme concludes. "However, there are many readily available alternatives, including the use of textiles to simply attach devices.

"To date, key successes have been found in applications where the aesthetics are of less importance, where washability is not a major concern, and where the value is both critical and cannot be replicated by other means."

IDTechEx has published a report: *E-Textiles and Smart Clothing Markets 2023-2033: Technologies, Players, and Applications*.

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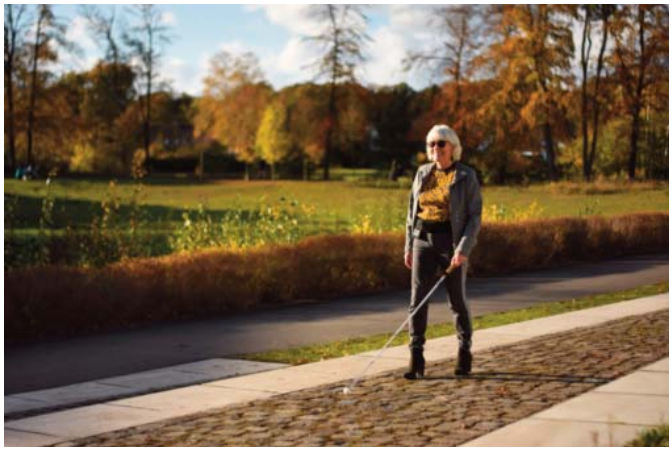
Demonstrator manufactured using ultrasonic welding. Photo: FeelSpace

E-TEXTILES

Vibrations lead the way with ultrasonic welding

The German Institutes of Textile and Fiber Research Denkendorf (DITF) have developed a contacting process in which a navigation aid that helps visually impaired people – and e-textiles in general – can be produced more economically and conveniently.

A navigation belt helps visually impaired people reach their destination. The route to be taken is entered via an app and the belt guides a person in the right direction like a compass.


The navigation belt helps with orientation. Photo: FeelSpace

When a turn in the route is encountered, the naviBelt from FeelSpace vibrates. It signals which direction the person is facing and helps them find their way – not only outdoors, but also indoors.

The device incorporates 16 vibration elements arranged around the belt. Project partner Amohr developed the conductive belt, which is comfortable to wear owing to its high elasticity and enables contact with the vibration elements owing to integrated stiffeners.

The DITF team led by Tobias Hecht developed a process for the production of e-textiles that has previously been used for contacting microchips.

Compared with a conventional soldering process, the use of ultrasonic welding means that the contact points can be significantly reduced in size and the contacts fixed with pinpoint accuracy.

During soldering, the soldering material is melted and the contact points are heated. The hot solder melts, resulting in a relatively large heat input. The flow of the solder also creates unwanted stiffening away from the contact point, which impairs the function of e-textiles in particular. Ultrasonic welding, on the other hand, generates less heat, which protects the material.

Ultrasonic welding also has health and environmental benefits compared with soldering. In the soldering process, solder is mixed with flux, which produces harmful vapours that have to be extracted and filtered.

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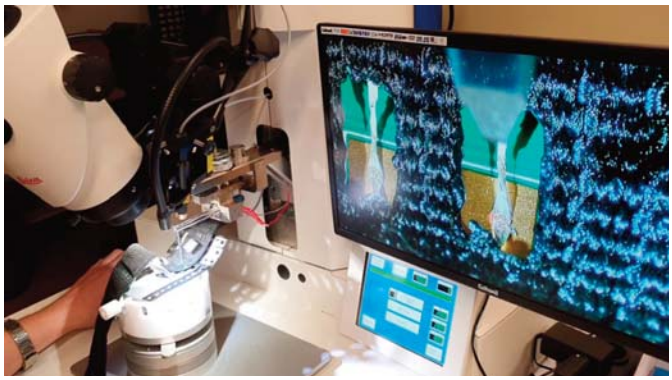

Contacting process with the help of the ultrasonic welding device (wire bonder). Photo: DITF

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E-TEXTILES

E-yarns for sport and healthcare applications

Electronic yarn (e-yarn) technology has been employed by a research group in Nottingham, UK, to create electronic textiles for healthcare, well-being and sports applications.

Addressing the E-Textiles 2023 conference held in November in Ghent, Belgium, Dr Theodore Hughes-Riley, associate professor in electronic textiles at the Nottingham School of Art and Design, Nottingham Trent University, described processes for fabricating e-yarns, including:

- soldering, in which a small electronic component is soldered onto thin, multi-strand Litz wires, which creates a robust mechanical and electrical connection between the wires and the component;
- encapsulation, where the solder connections and chip are encapsulated within an ultraviolet-cured resin pod along with reinforcing yarns, which ensures that the component and solder joints are fully protected from external mechanical and chemical stresses;
- fibre covering, where the ensemble is covered in a fibre sheath, normally a braid, such that the final yarn is thin, soft, flexible, drapeable and comfortable to wear.

These e-yarns can be used in such healthcare and sports applications as:

- motion monitoring, such as gait monitoring and fall detection;
- temperature sensing, e.g., in socks and cycling suits;
- pressure sensing, e.g., in pressure sensing compression sleeves;

A smart over-sock has been designed at Nottingham Trent University with an embedded inertial motion unit to detect fall events for older adults. It can differentiate between "activities of daily living" (ADLs) and falls with an accuracy of 99.4%, and between ADLs, falls and stumbles (near-falls) with an accuracy of 94.2%. Photo: Nottingham Trent University

The smart over-sock, which features a tiny motion sensor embedded in yarn, embedded at the ankle, can be connected to an internet-enabled device, such as a smartphone, via a detachable microcontroller using Bluetooth. Photo: Nottingham Trent University

- providing haptic feedback, where e-yarns with embedded vibrating motors have been developed; haptic e-yarns are also being used to develop a device to assist in communication with deafblind people.

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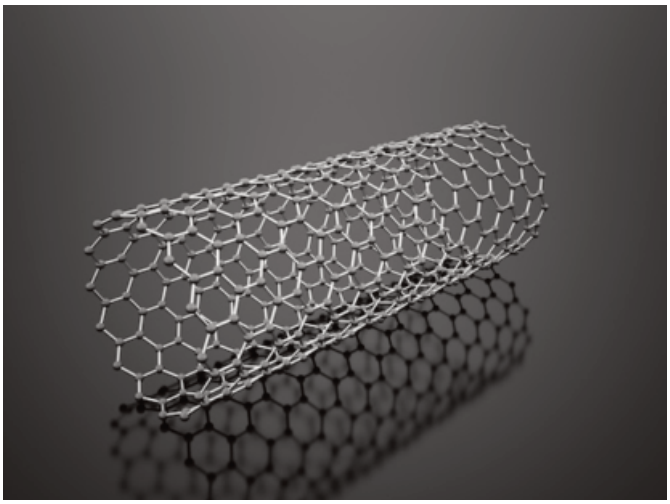
NANOTECHNOLOGY

Misconceptions remain over carbon nanotubes

The increasing use of carbon nanotubes (CNTs) – and a proposal by the EU to ban the entire class of materials – highlights the need for an updated and standardised



Misconceptions remain over carbon nanotubes, experts say. Image: Rice University

approach to assess human and environmental impacts of CNTs and products that contain them, according to a new collaborative study by researchers at Rice University, Houston, Texas, USA.

More than 5,000 tonnes of CNTs are produced annually for use in research laboratories and commercial industries. Owing to their unique properties, CNTs are used in diverse applications such as batteries, lightweight construction materials, functional textiles, wearable devices and increasingly in biomedical research.

"As we move toward a clean and diversified energy and materials revolution, the field of advanced materials needs a clearly defined science-based path in measurement, identification, classification and reporting throughout the entire material life cycle, from development to disposal, in order to fully scale CNTs across sectors and industries while also benefiting society and the environment," said Rachel Meidl, fellow in energy and sustainability at the university's Baker Institute for Public Policy and co-author of the study published in *Nature Reviews Materials*.

Toxicology and environmental persistence

In 2019, a non-governmental organisation in the EU added CNTs to a list of chemicals that it believes "should be restricted or banned in the EU", citing concerns from some of the many published works that studied the toxicology and environmental persistence of CNTs.

The authors of the new study investigated how CNTs have been classified chemically, given their many, diverse forms and ways to process, modify or use them. The results of toxicology and environmental studies varied widely, depending on these different CNT forms and how the studies were conducted.

"We realised that there were so many different forms of CNTs that it seemed strange that such diverse materials could even be classified under one name," said Daniel Heller, head of the Cancer Nanomedicine Laboratory at the Memorial Sloan Kettering Cancer Center.

"We also found that the toxicological and environmental risks of CNTs depend heavily on these differences, just like how different forms of silicon dioxide can either cause the lung disease silicosis or help keep your teeth clean as an ingredient in toothpaste."

Inconsistent picture of risk

The authors suggest that the volume and prevalence of these materials and the nuanced and inconsistent picture of risk requires them to be more precisely classified and defined in order to identify toxicological and environmental risks.

Investigators should adopt more consistent classification methods, measurement standards and consideration of potential toxicological and environmental impacts across the full life cycle of the materials that contain CNTs, including when they are used to replace more toxic or polluting materials, they said.

The authors recommend the construction of a comprehensive framework to classify, characterise and assess potential health, environmental and safety impacts of CNTs, because it would have a positive impact on both research and industry.

These tasks will provide policymakers with the data-driven tools to selectively regulate the subsets of CNTs deemed to be high risk, while ensuring that any restrictions on synthesis, production, manufacturing, use, transportation and disposal are science-based and minimally disruptive to the emerging field of carbon nanomaterials.

Additionally, transitioning to a circular carbon economy will mean that researchers will work to design out waste or use carbon-to-value pathways that deems end-of-use CNT and CNT-based products as a resource.

Energy transition

"CNTs may have far fewer energy and material requirements as well as fewer environmental and social consequences than other materials, making them ideal for the energy transition," said Matteo Pasquali, Professor of Chemical and Biomolecular Engineering and director of Rice University's Carbon Hub. "For example, they are the only credible alternative to copper and aluminium for large-scale electrification and to steel for large-scale construction.

"The toxicological studies conducted in the early days gave contrasting results and are no longer applicable to the new generation of materials, which is being made with much better control on structure, purity and macroscopic form," he continued.

"Standardising CNT classifications is necessary to sort the wheat from the chaff, so that policymakers will be able to minimise risks to workers and consumers while also creating regulatory certainty for industry, researchers and the general public."

The authors argue that approaching this problem from a systems perspective presents opportunities to:

- expand the application of carbon materials in industrial, commercial and medical sectors;
- support a dynamic and skilled workforce;
- ensure responsible development, use and end-of-life management from laboratory to market;
- help the world meet global climate targets and sustainability goals.

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NANOTECHNOLOGY

Improving stem cell growth with piezoelectric polymers

Weaving piezoelectric polymers into nanofibres reveals a surprising pathway to boost stem cell growth naturally, without external power, reports *Advanced Science News*.

Jinlian Hu, a professor in the Department of Biomedical Engineering at City University of Hong Kong, began studying shape-memory polymers, which eventually led to stem cell research. She studied how these polymers change shape in response to external stimuli, such as temperature, for the development of clothing that reacts to the wearer's environment.

Her success with these projects led to her study polyvinylidene fluoride that belongs to a unique class of materials known as piezoelectric materials, which can generate and transmit electrical currents when they are mechanically deformed, for example being stretched, pulled or pressed down upon.

Their piezoelectric nature, together with the fact that these polymers are soft, organic materials that mesh well with living tissue, makes them excellent candidates for medical applications like powering implanted devices, such as pacemakers.

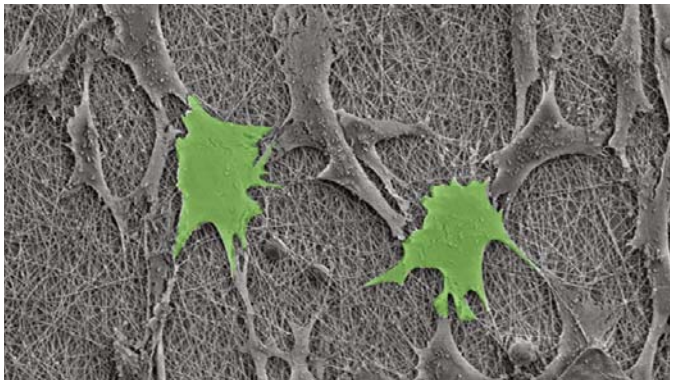

Image: City University of Hong Kong

When it comes to growing stem cells, these polymers are being studied for their ability to supercharge stem cell growth. While the mechanism is not entirely understood, researchers know that providing an electrical stimulus to stem cells improves growth and the cells' ability to differentiate into a specific cell type.

This is not surprising given that cells such as neurons, muscles and others use electrical charges to send and receive information. Piezoelectric polymers have been explored as a scaffold for growing new cells because they provide a charged and bio-friendly environment for living cells.

Piezoelectric properties

Hu and her colleagues set out to investigate ways to increase the piezoelectric properties of polyvinylidene fluoride nanofibres and use them as a scaffold for growing bone marrow-derived mesenchymal stem cells, a type of stem cell that produces bone. In a paper published in *Advanced Functional Materials*, Hu's team described two factors that improved stem cell growth.

First, to increase the piezoelectric properties of the nanofibres, the orientation of the molecules in the polymer must be shifted from the alpha phase to the beta phase. To achieve this. Hu used an annealing process, which increased the overall amount of beta phase-oriented molecules in the nanofibres.

Next, the team looked at how the fibres the cells would grow on could be arranged in a random fashion or an orderly aligned way. According to Hu, previous data showed that aligning the fibres produced a larger electrical output than a random arrangement of fibres. Therefore, they grew stem cells on annealed fibres in random or aligned configurations, as well as on random or aligned configurations of fibres that were not annealed.

Surprising result

As expected, annealing improved both growth on the ordered and random fibres compared with non-annealed random and ordered trials. But surprisingly, the cells grown on randomly arranged fibres grew better than on the aligned fibres.

The team investigated this phenomenon further and now believe that the random structure provides more surface area and texture for the cells to adhere to, which increases the amount of open ion channels. These channels line the surface of a cell and allow important ions such as calcium to enter.

The experiments showed the promise of this method for growing stem cells and, importantly, that this requires no external power. The piezoelectric charge generated by the cells growing on the fibres is enough to boost stem cell growth.

The next steps for Hu and her team are to look at other stem cell types and growth conditions and see if the random arrangement continues to improve growth. They will also look at optimising this protocol for the specific application of regrowing bone cells.

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COMPANY NEWS

Wearable tech firms lands deal with US sports retailer

New Zealand-based wearable technology company Myovolt is poised for growth after sealing a reportedly "seven-figure" non-exclusive deal with sports retailer United Sports Brands that will see co-branded products sold in thousands of stores across the US.

The business, which specialises in wearable vibration technology for muscle recovery and chronic pain relief, has been working to improve its product for the medical market over the past decade, and has enjoyed significant success in New Zealand's high-performance sporting arena, including rugby, rowing, cycling and cricket teams.

Myovolt was founded in 2025 by electronics and wearable technology experts Steve Leftly and Dr Dianne Jones. Over the past 20 years they have developed and produced garment-integrated electronics for NASA, the military and some of the biggest global brands.

The co-founders first met representatives from United Sports Brands at a trade fair in Europe. The partnership with the US retailer is now set to increase sales of Myovolt products in thousands of US stores, which will necessitate a significant increase in the company's production volume.

The first order under a new deal is reported to be larger than the past nine years of orders combined. Distribution to United Sports Brands outlets such as Dick's Sporting Goods, Academy and Big 5 will start in the first quarter this year.

Photo: Myovolt

"The first decade of Myovolt's journey has been a steady, systematic process of refining our product and building a strong clinical evidence base for the medical market," said Leftly.

"Overnight, the United Sports Brand partnership has changed our horizon and helped us stock our products in places that would never pick up our call a year ago."

The Myovolt technology offers a promising solution for muscle recovery and chronic pain relief. The device, worn as pads around the shoulder, leg, arm or lower back, operates on focal vibration therapy, a proven clinical method in reducing tension and stiffness in muscles and associated tendons and joints, according to the company.

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Funding for robotic glove to rehabilitate stroke patients

A medtech start-up that has created a soft robotic glove to help rehabilitate stroke patients has received new funding to accelerate its product to market.

Bioliberty has secured a £435,000 project from the Biomedical Catalyst, Innovate UK's flagship grant-funding mechanism, which is designed to transform innovative ideas into commercially viable businesses.

The Edinburgh, UK-based company's robotic glove works by assisting a patient to open and close their hand, an action that can be severely limited following a stroke.

Developed in collaboration with physiotherapists, occupational therapists and clinicians, the glove has built-in sensors that allows it to vary levels of resistance to tailor rehabilitation exercises to the user.

This new funding will go towards developing the machine learning and data collection elements of the product.

Bioliberty is based at the National Robotarium, a facility that works collaboratively with partners worldwide to define, develop and resolve industry challenges through the application of robotics and artificial intelligence.

According to the UK's Stroke Association, someone has a stroke every five minutes in this country affecting 100,000 people a year. It is estimated that 1.3m people in the UK have had a stroke with many requiring ongoing therapy to recover from the symptoms.

New guidelines from the National Institute for Health and Care Excellence published in October state that stroke victims should receive up to three hours of rehabilitation a day, five days a week.

However, the Stroke Association has voiced concerns over the UK's National Health Service's ability to deliver on this target.

Bioliberty, which has already raised more than £3.5m in private and public funding and created eight new positions within the company over the past six months, believes the

Soft robotic glove. Photo: Bioliberty

new technology can help deliver on these new guidelines.
Contact: Bioliberty Ltd
Email: shea@bioliberty.co.uk
www.bioliberty.co.uk

Bionic leg sleeve named design project of the year

The Cionic Neural Sleeve has been named as the design project of the year in the Dezeen Awards 2023.

The neural sleeve, developed by design studio Fuseproject in collaboration with California, USA-based start-up Cionic, was also named product design (health and well-being) project of the year.

The lightweight Cionic Neural Sleeve wraps around the leg and uses electric pulses and artificial intelligence to correct muscle movements in people with limited mobility.

According to the design master jury, "The design does not have a medical appearance which helps to remove any stigma for the wearer. Clever integration of technology into a fabric which has the far-reaching possibility to vastly improve the quality of life for many."

The jury said the bionic leg product represents "a perfect marriage of science, technology and design. For the millions of people suffering from muscular degenerative diseases or injury, this product has the greatest potential to improve the user's ability to walk and therefore their quality of life.

"Working with sophisticated technologies, the Fuseproject design studio has managed to conceal complex electronics into a slender product that wraps elegantly around the leg without an overly medical appearance."
Contact: Cionic Inc
Tel: +1 415 237 1715
Email: info@cionic.com
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Fuseproject
Tel: +1 415 908 1492
Email: info@fuseproject.com
www.fuseproject.com

www.textilemedia.com/smart-textiles-and-wearables/

Myant appoints new chief of staff

Dr Georgette Zinaty

Canada-based digital health technology company Myant has appointed Dr Georgette Zinaty as its new chief of staff.

She holds a Doctorate in Business Administration, a Master of Science in Business Research, an MBA with a focus on strategic marketing and human resources and a certificate from Harvard University leading change in organisations.
Contact: Tony Chahine, Chief Executive Officer, Myant Inc
Tel: +1 416 423 7906
Email: info@myant.ca
www.myant.ca

EVENTS

E-textiles for healthcare

The E-Textiles Network workshop "E-Textiles for Healthcare" will be held on 16 January 2024 at the University of Southampton, UK.

The workshop will explore the role of wearable technology in healthcare and then identify opportunities for e-textile smart garment-based wearables and the corresponding research challenges that need to be addressed.

The workshop will be run as a one-day event, split into two halves with the morning session focusing on technology within healthcare and the afternoon focusing on how this technology can be implemented in e-textiles and the associated practical challenges.

There will be a number of talks from leading industrial and academic speakers, including:

- Prof. Philip Chapman-Sheath (University Hospital Southampton) – Clinical Needs in Orthopaedic Surgery: E-Textiles and More;
- Dr Peter Charlton (University of Cambridge) – Using Wearables for Clinical Decision Making;
- Prof. Age Chapman (University of Southampton) – So you have the data. Now What?;
- Tim Budd (IMed Consultancy) – Translating Research into a Commercial Medical Product: Bridging the Product Development Gap;
- Prof. Ian Craddock (University of Bristol) – Wearables in Ambient Assisted Living (tbc);
- Prof. Kai Yang (Winchester School of Art) – Development of E-Textile-Based Medical Devices for Managing Chronic Conditions;
- Simon McMaster (Footfalls and Heartbeats) – Intelligent Apparel – The Health Data System of the 21st Century.

Contact: E-Textiles Network
Email: info@e-textilesconference.com
www.e-textilesconference.com

DIARY OF EVENTS

January 2024

16 January 2024
E-Textiles for Healthcare
E-Textiles Network Workshop
Southampton, UK
Contact: E-Textiles Network
Email: info@e-textilesconference.com
www.e-textilesconference.com

February 2024

21-22 February 2024
innoLAE – Innovations in Large Area Electronics Conference
Cambridge, UK
Contact: IMI Europe
Tel: +44 1223 236920
Email: info@innolae.org
www.innolae.org

April 2024

9-12 April 2024
Techtextil
Frankfurt am Main, Germany
Contact: Messe Frankfurt
Tel: +49 69 7575 5889
Email: techtextil@messefrankfurt.com
www.techtextil.com

November 2024

19-21 November 2024
E-Textiles
5th International Conference on the Challenges, Opportunities, Innovations and Applications in Electronic Textiles
Berlin, Germany
Contact: E-Textiles Network
Email: info@e-textilesconference.com
www.e-textilesconference.com

Submit your event listing to: The Editor, Smart Textiles & Wearables. 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 PUBLICATIONS

Medical Textiles
A monthly update on the use of textiles for medical applications – one of the fastest growing sectors of the technical textiles industry. Each issue covers technical developments in materials and applications – fibres, yarns and fabrics, equipment, surgical and orthopaedic applications, dental uses and hygiene – together with standards, market and industry news

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

Download the full publications catalogue or order online at www.textilemedia.com

COMPANIES IN THIS ISSUE