

From electronics to sensors and from graphene to glass beads, new materials and functions are being spun into yarns and threads for stitching, embroidery and textile manufacturing.

How to spin a smart yarn

Throughout time, and despite the emergence of ultrasound and various heating and melting solutions, stitching remains the main method of assembling two pieces of fabric. The sewing thread will most often be made in a multiple plied and twisted polyester and will hold for the duration of the intended use of a garment. It may even last longer when used to stitch the seams of apparel made in fine natural fibre fabrics.

For Cédric Vanhoeck, a Belgian industrial design engineer, this might not be necessary and might not even be desirable. During his training as a fashion designer he told *WSA* that he was surprised, , by how few young designers seemed concerned by the environmental impact and end of life of clothing they created. Inspired by the notion of design for disassembly, he began working on a sewing thread that dissolves at a given temperature and founded Regeneration, with Vanessa Counaert, in 2017. Resortecs, the name of the yarn, can simplify the process of recycling clothing by removing zippers and buttons and unstitching seams. The start-up won an H&M Global Change Award in 2018 and received a € 100,000 grant from Vlaanderen Circulair, a Flemish circular economy innovation programme, in January this year. These funds will help optimise the three threads in development and launch pilot tests. The company is working on yarns that melt in a range of 160-200°C, and include a biodegradable thread that Mr Vanhoeck says disappears in 24 hours. Resortecs could facilitate the recycling of multiple-material clothing by removing linings from jackets for instance, (which would be useful for automatic sorting machines like the Fibersort) or to separate shoe uppers from soles. The company has recently made progress in industrial production and has begun work on different colours, including black, white, blue and gold-orange, the latter for denim applications.

Sewing threads represent a minute portion of an item of clothing (1% at most is the common thinking), composition labels rarely indicate their

Belgian start-up Resortecs has developed a dissolving yarn designed to facilitate the disassembly of clothes for recycling.

GCA-H&M Foundation

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presence, but no one would contest their structural importance and possibility for innovation. This is something that Coats, a leading supplier of apparel and industrial threads, headquartered in Uxbridge, UK, takes seriously. It recently opened an innovation centre in Bursa, Turkey, completing a global network that includes two other hubs located in Shenzhen, China and North Carolina in the US.

The sewing thread maker has developed conductive sewing threads that can be used to power microchips or sensors. "These can be embedded in clothing or composites," says Coats' head of innovation, Richard Ridewood. But these are niche applications and the company is focusing its efforts on shifting all of its standard sewing threads to 100% recycled polyester by 2024. Now is the time for the company "to secure sourcing," says Mr Ridewood. Coats acquired Patrick Yarns in late 2017, a company making yarns from recycled bottles without dyeing them. Called Earthspun, the range is available in nine shades including ketchup red, mustard yellow and beer brown.

In late 2018, Coats invested $5 million in Twine Solutions, an Israeli start-up founded in 2015 by brothers Alon and Erez Moshe. The digital and waterless thread-dyeing machine they designed produces yarns in small batches and in any colour, a process that could speed up sample manufacturing and reduce its environmental impact. "If you can print the thread, you remove all the wet processing and significantly reduce its environmental footprint," says Mr Ridewood, adding that the equipment can be placed anywhere, even close to the consumer. Coats will be officially announcing its partnership with Twine Solutions at ITMA in June.

Authentication and security

An RFID tag in a thread-like format, E-Thread developed by Primo 1D, a company based in Grenoble and founded in 2013, also addresses supply chain needs for the fashion industry. It has been made possible by the "extreme miniaturisation of electronic components, making them small enough to be integrated into a yarn," says Primo1D chairman, CEO and co-founder, Emmanuel Arène. CEA LETI, a French technology research institute, helped develop the patented smart thread and one of the start-up's industrial partners is Massebeuf Textiles, a spinner that also helped develop CRY, a retroreflective yarn, for JRC-Reflex.

The E-Thread module is made up of an RFID UHF (Ultra High Frequency) microchip and an antenna measuring 13 cm. It can be delivered in spools or cut into units for integration inside hems or seams. The company says it can now be integrated into rubber and thus equip shoe soles.

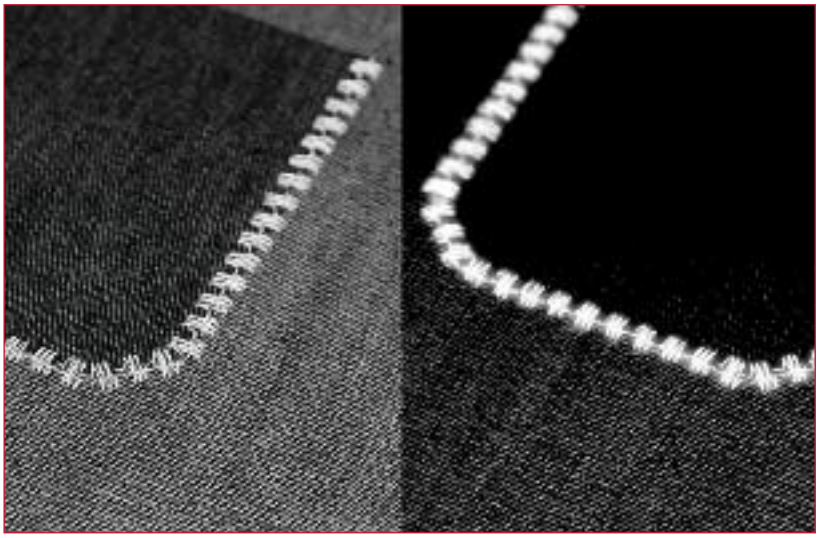
Like any RFID tag, it can be read and written on from a distance of up to ten metres, says Mr Arène. Primo1D initially intended to integrate the yarn into fabric manufacturing but this was found to be too challenging, compared to placing the smart device in seams and thereby providing a supply chain tool to fast-fashion retailers. "Our smart yarn can help them identify in real time the flow of product, whether in store or on-line, and can also be used in automated check-out systems. It can read up to 100,000 objects at the same time and can be used for traceability, authentication or inventory purposes," says Mr Arène. It can also serve as an antitheft device as it will be invisible inside clothing, footwear or accessories. "It will not have any impact on a product's structure or form," adds Mr Arène in reference to a possible risk of delamination in plastics or tyres (Michelin is a new backer).



UK-based sewing thread manufacturer Coats has opened three innovation hubs to accelerate innovation with its clients.

Coats

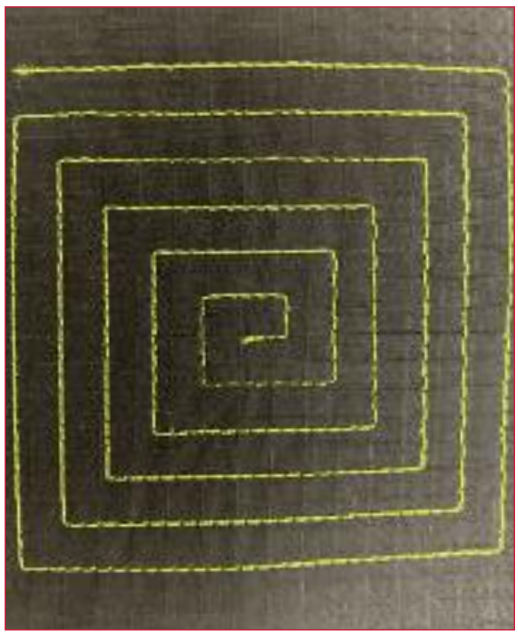
Coated Reflective Yarn (CRY), a yarn coated in glass micro-beads, developed by French retro-reflective specialist JRC-Reflex (and featured in *WSA*) is being used in sewing, embroidery and knitting. Since its launch, the range of counts has been expanded to include a reference fine enough to be integrated into gauge 22 seamless



An example of what German embroidery specialist Gunold can offer with CRY, a retro-reflective yarn developed by JRC-Reflex.

Gunold-JRC-Reflex

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Volt Smart Yarns, a division of US-based Supreme Corporation, is looking to make a SansEC smart yarn based on a wireless technology developed by NASA.

Volt Smart Yarns



The machine developed by Swedish start-up Coloreel applies colour during the embroidery process and introduces novel design possibilities.

Coloreel

circular knits and a yarn that can be dyed. "It is now possible to make a greige knit and dye it in any colour," says company CEO, Céline Cugerone, who adds that counts for gauge 24 and 26 circular knitting machines are in the works. The company is also looking to develop heavier yarns, laced with Kevlar, high-tenacity polyethylene or even linen, for applications in high-end leathergoods.

Another version of CRY has a fibre optic or conductive core that can power sensors, LEDs and transmit data. It was developed by JRC-Reflex for Volt Smart Yarns, a division of US-based Supreme Corporation, that markets it. "CRY reflective conductive yarn can be used as an accent piece. If an LED light is placed at the wrist, it can be used to connect it to a battery and create a visually graphic element on the arms and shoulders for instance," says Supreme Corporation CEO, Matthew Kolmes.

Specialising in high-tech and high-strength yarns, the US yarn converter has recently acquired the licence for a technology developed by NASA known as SansEC ("sans" meaning "without" in French and EC standing for Electrical Current). The electromagnetic resonance-based sensing method does not require a battery nor a Bluetooth connection, says Mr Kolmes. "The yarn vibrates when hit with a frequency. If you place it near something, such as a heart, it can read the electrical signals the heart emits." Though it can operate without a power source, it does need special software and hardware (which can be a smartphone or tablet) to be read or rather "interrogated", the term NASA uses, he tells *WSA*. Work is under way on software and hardware and possible applications include military and medical fields. A smart bandage capable of monitoring healing could be market-ready by the end of 2019.

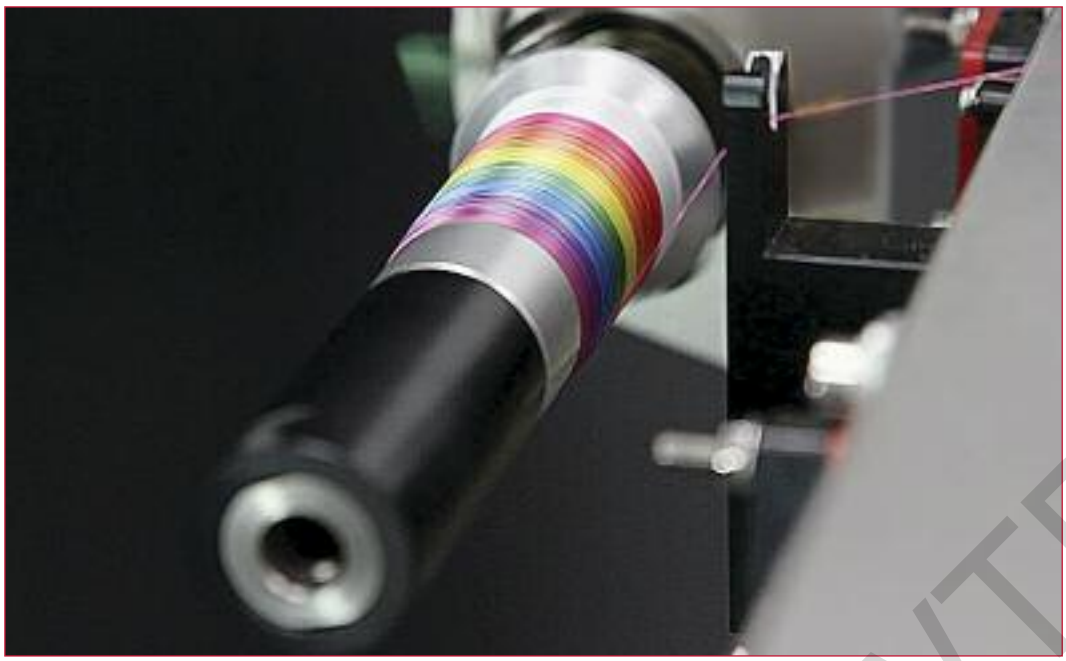
Volt Smart Yarns is also working with Vomaris, a company based in Tempe, Arizona, on its V.Dox technology that embeds moisture-activated microcell batteries in cotton. "These could power our sensors," says Mr Kolmes, adding that the two companies are also working on developing new heating and cooling properties for textiles, which would also be based on NASA's thermocouple SansEC technology.

Innovation in embroidery

A versatile method of combining high-tech yarns and textiles, embroidery is not only used for adornment but can integrate conductive and electronic components into a fabric. However elegant, this solution has been slow to come to market. Reiner Knochel, an embroidery specialist formerly at Madeira, who launched his own consultancy, Textile Experience, in 2016, points out that other solutions may be cheaper. For ornamentation purposes, he sees demand growing for high-tech special effects, like the retro-reflective CRY yarn or phosphorescent glow-in-the-dark yarns. German embroidery yarn specialist Gunold offers both, as it holds exclusive rights to the distribution of CRY for embroidery applications.

Innovation in embroidery is just around the corner, as Coloreel a company based in Jonkoping, Sweden, begins delivery of its

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The colour-on-demand machine created by Twine Solutions, an Israeli start-up, is designed to simplify the manufacture of samples in the fashion industry.

Twine Solutions

miniaturised dyeing factory, designed to be placed on existing embroidery equipment. In development for ten years, the system applies a series of processes that dye, bind, wash and wax an embroidery thread. "The resulting yarn is colourfast, washable and will not bleed," says company CEO, Mattias Nordin.

The yarn used is a specially selected polyester, representing more than half of the embroidery market, says Mr Nordin. Coloreel expects to develop thicker and thinner yarns, which would cover an additional 20% of market demand. The company is also working on sewing threads that could introduce new design possibilities to buttonholes, car seats or jeans.

Graphene and conductivity

Progress in graphene-based textile materials continues and includes yarns, as announced by a team of researchers, including Shaila Afroj and Nazmul Karim, at the Manchester University National Graphene Institute (NGI), whose findings were published in *ACS Nano*. The team says it has developed a method of producing a conductive graphene yarn at scale, using existing textile machinery and without adding to production costs, a project it has been working on since 2016. The method involves graphene flakes engineered to adhere to a yarn during dyeing. "We functionalise the graphene so that it interacts with the textile yarn," Nazmul Karim tells *WSA*. The yarns can be integrated into a knitted fabric and function as a sensor or transmit data wirelessly via RFID or Bluetooth. The graphene textile sensor is claimed to show excellent temperature sensitivity, washability and high flexibility, which would make it suitable for integration into clothing.

It can also have UV-blocking, antibacterial, antistatic and abrasion resistance properties. These are some of the options being explored, but smart textiles are the current 'sexy' application. "Metal-based yarns are not always suitable for next-to-skin applications," says Mr Karim. And though graphene may solve some issues related to wearables, challenges remain, as graphene is not as conductive as metal, he points out.

Rethinking functionality from the yarn up is the innovative business model that FilSpec, a Canadian spinner based in Quebec, seeks to expand into Europe, with the opening of a sales and development office in Belgium in April. "Around 80% of a fabric's performance comes from the yarn," says FilSpec president, Eric Perlinger. This approach covers all aspects of a functional textile, from antibacterial properties to conductivity, though the process of introducing smart functions into modern spinning facilities is far from easy. "Smart yarns represent less than 1% of our sales, but they eat up 30-40% of our R&D resources," Dominique Quintal, vice-president in charges of sales and marketing, informs *WSA*. He also insists that research into more sustainable methods of producing garments is also necessary. The company is currently looking into two possible new markets, including hemp (Canada having now legalised the farming of the natural fibre) and recycling. "The raw materials are available here in Canada, be it hemp or used clothing that we can shred and make into yarn," says Mr Quintal.

As progress remains slow in wearables, many companies appear to see more potential in sustainable applications and materials. The breadth of the new products in development and on the way to market, from dissolvable to waterless dyed-on-demand yarns, indicates that even age-old techniques like sewing and embroidering can be given a new twist.

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