

Interactive Fashion and Smart Textiles

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Digital innovations are transforming the landscape of apparel and traditional textiles. Across multiple industries, the application of smart textiles with embedded, sensitive components is set to revolutionize and redefine our existence. As we move forward towards Industry 4.0, technology is now an essential component of our daily lives. However, how we experience technology is set for radical change.

Mobile devices now seamlessly connect to create data that both informs and educates our choices. How we use this data and technology is of paramount importance, and continues to empower a new generation of industries, encompassing fashion, sportswear, workwear, outdoor, automotive, healthcare, interior decoration, retail, entertainment, and leisure. Data is the new gold, and information is power!

Collaboration has been an essential factor in this new world of possibilities. Working together, academia, chemists, scientists, designers, and product architects are reinventing the fibers, threads, yarns, and fabrics that we spin, weave, print, and manufacture. In doing so, they begin to build the essential manufacturing infrastructure that is required for scalable manufacturing.



The Magic of Graphene

One such example of collaboration is the Manchester National Graphene Institute (MNGI). Over 80 companies have already partnered with The University of Manchester, working on graphene applications. These collaborations offer industrial partners the opportunity to work alongside world-leading academics. MNGI currently has over 300 people working on new research for graphene and 2D materials.

Graphene holds a host of properties that include thermal, electric, electro-magnetic, and anti-bacterial characteristics, which offer incredible opportunities for numerous industries. Graphene is stronger than steel, and can now be used as a conductive, flexible yarn thanks to the research of a team of scientists lead by Nazmul Karim and Kostya Novoselov at Manchester University. This team has developed the world's first scalable graphene yarn for wearable textiles. The yarns are lightweight, biodegradable, washable, and inexpensive.

“High performance clothing is going through a transformation currently, thanks to recent innovations in textiles. There has been growing interest from the textile community to utilize the excellent and multifunctional properties of graphene for smart and functional clothing applications. We believe that our ultra-fast process for graphene-based textiles will be an important step towards realizing the next generation of high performance clothing,” says Karim.

Previously, the components required for conductivity have been a hindrance to the development of

wearable textiles. They were often bulky, heavy, and cumbersome and were seen as a negative addition by the fashion industry. Graphene is incredibly lightweight and does not interfere with the natural drape of a fabric. Therefore, it offers an exciting new yarn that can deliver seamless, immersive electronics for apparel with no loss of comfort for the consumer.

Graphene yarns now offer an exciting future for multiple applications. “To introduce a new exciting material such as graphene to a very traditional and well established textile industry, the greatest challenge is the scalability of the manufacturing process,” Shaila Afroj, who carried out the project during her PhD research, says. “Here, we overcome this challenge by producing graphene materials and graphene-based textiles using a rapid and ultrafast production process. Our reported technology to produce a thousand kilograms of graphene-based yarn in an hour is a significant breakthrough for the textile industry.”

In collaboration with the MNGI and INTU, CuteCircuit manufactured the world's first haute couture “Little Black Dress” using graphene. A first for the fashion industry and an important marker for the future of functional fashion, the graphene Little Black Dress showcased the future uses of the revolutionary material in creating the ultimate fashion statement.

The dress features a stretchable graphene sensor that captures the rate of the wearer's breathing. The micro LED embroidered across the bust on translucent conductive graphene responds to the sensor, making the LED glow and change color depending on the breathing rate. The 3D printed graphene filament shows the intricate structural detail of



graphene in raised diamond shaped-patterns and showcases graphene's unrivalled conductivity with glowing LED lights.

"This was such an exciting project for us to get involved in!" Francesca Rosella, chief creative director for CuteCircuit, says. "Graphene has never been used in the fashion industry before and being the first to use it was a real honor...showcasing graphene's amazing properties."

Sensory experiences are an essential element to the human existence. While many of us take them for granted, for those of us who are without sight or sound, wearable technology offers a new freedom and independence. Examples are the Sound Shirt and the Hug Shirt, both developed by CuteCircuit. Each have embedded sensors that act to deliver a translation between a remote sound or function, by re-delivering the sense as a series of pulses. These can transmit an emotion, touch or sensation, perhaps a warning, or important thermal warmth.

As these products evolve, the applications are endless for the medical, leisure, military, automotive, performance apparel, and entertainment industries. Applied alongside augmented reality (AR) and virtual reality (VR) technologies, the lines between reality and sensory experience can be duplicated, blurred, or enhanced.

Printing Gets Smart

New technical advances continue to drive the development of smart textiles that are capable of being produced on a mass scale. An important driver of such change is digital ink jet technology.

Driving Innovation

In a recent performance featuring fiber optics and printed UV-sensitive inks at the Brooklyn Ballet, the ballerina's tutus were brought to life by Interwoven Design in New York. Rebeccah Pailles-Friedman, founder and principal of the Interwoven Design Group and author of *Smart Textiles for Designers, Inventing the Future of Fabric*, is a professor of Industrial Design and Fashion at the Pratt Institute.

"Smart textiles are one of the most exciting and ground-breaking developments in materials science," she says. "Athletic clothing, functional apparel, and protective gear have been at the forefront of adopting smart textiles—even driving their development and innovations. These areas all have a function to achieve. Fashion's function is performative. Smart textiles, with the ability to achieve new 3-dimensional forms, new ways of applying and delivering color, the ability to house electronics, and answer some of the most difficult sustainability problems, are driving innovation on the runway."



Funxion is pioneering a new generation of printable conductive materials. Using digital ink jet technology or screen printing they have developed a new generation of printable inks applications that can deliver heat, color, or sensation. The inks offer a biodegradable process, are lightfast, remain washable for up to 500 washes, and do not add unnecessary weight to the textile. Powered by magnetic batteries, the technology is both functional and versatile—offering the industry a scalable suite of tools for application in numerous sectors.

The apparel industry faces a systemic change and an insatiable thirst for customization and personalization. Funxion's technology will enable personalization. For the fashion industry, that will facilitate incredible creativity, and for the health and military sector, offers a fully customizable solution for medical and security applications.

Personalizing smart garments by size, color, individual measurements, or client specifications can be achieved by using digital textile technology. Funxion's technology can be applied after traditional or digital textile printing, knitting, or weaving, or

custom printed onto ready-made sewn garments, facilitating personalized direct-to-garment (DTG) manufacture and infinite product choice. Indeed, it can also be printed onto the yarns prior to manufacture with infinite applications for the innovative apparel brand.

Loomia wants to give clothes an invisible high-tech makeover. Using a conductive electronic layer that can emit light or heat, the technology has been used in proto-types by North Face and Calvin Klein. Created using digitally-printed ink jet technology, Loomia's conductive circuit boards have a natural drape and resist creasing, but are importantly flexible and stretch with the garment for essential wearability. Not only focused on fashion, Loomia is also developing new products for the automotive industry.

Data

Also driving change within wearable technologies is software and artificial intelligence (AI) data. One example is a recent marketing collaboration between Schweppes and Ogilvy, a Brazilian marketing agency, for their client Coca Cola. The "Dress for



Respect” campaign highlighted the use of e-textiles for the collection of data.

They created a fashion garment—in this instance a touch sensitive dress—which was worn by a number of models in a Brazilian nightclub. Hidden within the garment were strategic sensors that measured and transmitted data when the garment was touched. Data is the new gold dust for many fashion brands, but in this case also measured unwelcome attention for the models.

The data was wirelessly transmitted and formed the basis of a study of social behavior. Recording biometric data is a sensitive area, but this is a great example of the potential applications for wearable technologies.

The Future is Now

Clothes that react to our mood, needs, and wants are here. Imagine the possibility of a conductive pattern that changes with the ease of a digital screen? Patterns that change with a triggered temperature or sound?

Using VR, the ability for wearable apparel to seamlessly connect the user to unlimited experiences offers

incredible opportunity. Visual display will now be an extension of fashion in the real world and the virtual.

Fashion will soon become a second skin that displays optical illusion, or camouflage on demand. Not so sci-fi as it once sounded, the technology is here, the future is Now.



With 25+ years of professional multi-disciplinary experience in design and textile manufacturing, **Debbie McKeegan** serves as an expert authority on digital disruption. As a digital print pioneer, she has participated in the reform of the print industry and continues to devote her career to digital technologies and their application across the entire textile space. www.texintel.com