RISE TO THE CHALLENGE: DIRECTA PLUS, VITTORIA AND COLMAR

Part of a famous list of accidental scientific discoveries and of a separate list of innovations that have led to Nobel prizes, graphene made a long-awaited commercial breakthrough into the sports and outdoor markets at the start of 2016 thanks to joint projects involving Italian companies Directa Plus, Vittoria and Colmar.

Graphene makes an outdoor apparel breakthrough



Graphene, discovered by chance, is stronger than steel, harder than diamond and more conductive than copper.

Directa Plus

Sometimes, Professor David Gann of Imperial College London relates, a scientific discovery is the fruit of years, even a lifetime, of labour and reflection. On other occasions, it's more a question of serendipity, although he is in complete agreement with Louis Pasteur that "chance favours the prepared mind". Nevertheless, there's serendipity and then there's graphene.

"For some scientific breakthroughs we need the Large Hadron Collider," the professor says. "For graphene what was needed was sticky tape and a pencil. Graphene comes from graphite and its discoverers, University of Manchester researchers Andre Geim and Konstantin Novoselov, found in 2004 that it's possible to de-layer graphene from three dimensions to two and make it into a single-item sheet." This is exciting, he explains, because it turns out that this single-item sheet forms "the strongest material we have, stronger than steel, harder than diamond and a million times more conductive than copper". It has what he calls "an array of material attributes" that we would never have been able to design.

Push for patents

In 2014, technology companies around the world registered 9,000 graphene-related patents compared to 1,000 in 2010. The professor, who describes himself as a "technology trainspotter" calls this an exponential rise, and he says it signals huge excitement around graphene in technology communities across the world. The graphene market had a value of around $20 million in 2014 but market leaders have now seen a big opportunity, David Gann says. He adds: "Almost every industry could be touched by this material."

No toxicity

Giulio Cesareo, chief executive and co-founder of Italian company Directa Plus, was early to the party. He founded the company in 2005, establishing its headquarters in Lomazzo, near Milan. It has designed a production system around super plasma expansion, subjecting graphite to temperatures around 10,000 degrees Celsius, increasing the distance between the layers in natural graphite, which is abundant, making it easier to separate those

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layers and make graphene. It's a physical process only; it uses no chemicals so there is no toxicity, Mr Cesareo explains. "If you tried to do what we do with chemicals, you would introduce toxicity," he adds. Directa has 12 of the graphene patents granted so far and another six pending. He says that coming up with a production unit that works well, which means producing large quantities of material of consistently high quality without compromise on quality, took his company five years and 1,600 experiments. In 2014, the production unit had an output of 30 tonnes of graphene-based products for use in a range of consumer and industrial markets but is expanding all the time and is projecting 300 tonnes in 2016.

The Directa Plus chief executives says the material is accordion-like, which expands and expands with all the layers remaining connected. His company's secret lies in being able to make the graphene into liquid, powder or paste (products that, collectively, have the name Graphene Plus, or G+) for use in materials that have applications as wide-ranging as self-repairing lightweight skins for aircraft bodies to materials that can remove hydrocarbons from water. Professor Gann predicts possibilities that include graphene going into robots to give the robots "a sense of touch" that imitates ours, as well as into prosthetics and "many avenues in the health sector".

Outdoor and sports breakthrough

And now textiles have also become part of the picture. High-end outdoor brand Colmar is in the vanguard for putting graphene-enhanced fabrics into outdoor and sports apparel in a collection it unveiled at ISPO 2016 called, simply, G+. This inaugural G+ collection comprises ready-to-wear ski jackets (for men and women), ski suits, technical underwear and a polo shirt aimed at the golf market. The two Italian partner companies insist the presence of graphene in these garments will "significantly improve performance for the benefit of athletes, professionals and sports enthusiasts".

Colmar managing director, Giulio Colombo, says using graphene-based materials has given Colmar the ability to endow its garments with better thermo-regulation than ever before. "When you are skiing, your body creates heat; a hot-spot forms in particular places inside your jacket," he says. "What G+ has allowed us to do is spread that heat to the whole garment, to the wearer's whole body in a way we have never been able to offer before with other thermo-regulating fabrics. And in summer, with our golf collection, the same feature, spreading heat, has the opposite effect and makes the body feel cooler."



At ISPO 2016 Colmar became the first outdoor company to show off a graphene-enhanced apparel collection.
Colmar

A hard road

He says it had been a "difficult road", but Colmar and Directa Plus have been able to find a solution that works in high-end sports garments in about a year. Mr Colombo says he can foresee many types of application and he knows other sports apparel brands will follow Colmar's lead. "We are first," he says, "and that gives us an advantage. But we know we cannot be exclusive users of graphene in this way. This is only the beginning."

Directa chief executive, Giulio Cesareo, confirms that this is the first time Graphene Plus has been used in sportswear, and the first G+ textile product to reach the market. He believes this represents a significant milestone and repeats that the sector offers tremendous opportunity. "We believe this is the beginning of a revolution in the world of sportswear and the textile industry as a whole," he adds. "Colmar have proven that they are pioneers and we wish them all the success."

The two companies' contention is that Graphene Plus-enabled apparel will have an increased ability "to act as a filter between the body and the external environment, always ensuring the ideal temperature for the wearer". Fabrics treated with Graphene Plus are also electrostatic and bacteriostatic, giving them reduced friction with air and water.

WORK IN PROGRESS



Independent tests have shown that G+ Isotech tyres from Vittoria can give cyclists a 32-second advantage over the course of 50 kilometres.

Vittoria/Directa Plus

Giulio Colombo says Colmar, which was founded by his grandfather, has always given high importance to fabric technology. "Technology in activewear is developing really quickly," he observes, "and we're always looking for something new." G+ appeals to him because of its performance capabilities. And, yes, there are other fabrics on the market that offer thermoregulation capacity, some of which Colmar has employed in previous collections. "But the thermoregulation with G+ is something I have not seen with other fibres and fabrics," Mr Colombo says. "It really spreads the heat and will work in summer and in winter."

Olympic gold for graphene

One sports application of Directa Plus materials, though not an apparel one, that has

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been in place since last year is its use in a graphene-enabled range of bicycle tyres from Italian wheel and tyre manufacturer Vittoria. Its chief executive, Rudie Campagne, is a former executive of major consumer electronics firms, including Philips and Thomson; based in Singapore towards the end of that stage of his career, he said he wanted to return to Europe and wanted to do something new. He went to Italy rather than to his native country, the Netherlands, and was part of a small group of investors that acquired Vittoria. After a chance meeting with Giulio Cesareo, his company began a joint project with Directa to see if graphene in bicycle tyres, which seemed a fine idea in theory, would work in practice.

"My world is sport, racing cycling," he says, "and what keeps me awake at night is the thought of that sport's great heroes going down mountains at 100 kilometres per hour, watched by millions, with just a helmet to protect them if a tyre blows. Tyres, in this context, are a matter of life and death."

He explains that in the world of bike tyres, gaining speed has traditionally meant losing grip, and vice-versa. "Not now," he insists. "With the tyres we have developed with Directa—our G+ Isotech tyres—riders can increase speed and grip at the same time. The tyres are intelligent, they become harder when rolling straight and softer when the rider brakes or takes a corner, therefore offering extra speed and extra grip exactly when required. Graphene is a dream come true for us." He explains that the tyres are also puncture-proof; if you go over a nail, the tyre starts closing itself immediately, before the tyre starts to lose pressure.

32-second advantage

Vittoria launched the new G+ Isotech tyres at cycling exhibitions in the autumn of 2015 and says a number of cycling teams will use the new equipment in the course of 2016, and that individual athletes and national teams are also preparing to use them at the Rio Olympics in August.

Rudie Campagne says independent tests in a laboratory in Finland have shown the G+ Isotech tyres to offer a 32-second advantage over a distance of 50 kilometres, compared to tyres previously recognised as leading the market. He points out: "If you think that the Tour de France can be won by just a few seconds after three weeks, 32 seconds over 50 kilometres is an enormous advantage. Gold medals at the Olympics will still depend on the riders' strength and skill, but we are certainly going to give them all the help they need."



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