Explorers

Andrea Ferrari: the graphene guru

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Andrea Ferrari is one of the world's best known experts in one of the world's most exciting new materials: graphene. Yet he is also a cautious one.

In a world where scientific breakthroughs are often heralded as game-changing technologies the day after they emerge from the laboratory, Ferrari is keen to stress that we shouldn't rush to conclusions. "I never speak about wonder materials," he says.
"Sometimes there is an unrealistic expectation that after one day you immediately have something on the market."

Graphene has certainly been billed as a "wonder material" in the past, because its ability to add strength and electrical conductivity means it could be used to improve everything from concrete to touchscreen smartphones. As Ferrari tells Euronews Explorers: "What is amazing about graphene is that in the lab you can basically make anything you want with it."

The challenge that Ferrari is facing as he directs the Cambridge Graphene Centre is how to take it from the lab into the outside world. However, this Professor of Nanotechnology at the University of Cambridge, England, stresses that graphene has time on its side. Work began in earnest in 2004, "But it was only around 2009-2010 that engineering, material science, and companies took notice of this material," he explains. "So despite what people may think, we are still in a very early stage of investigation"

For the moment, if you want to buy something mainstream that features graphene, you had better be used to thwacking a ball around, sliding down hills or peddling on two wheels, because some of the only easily accessible graphene products are items like tennis rackets, skis or bicycle wheels, which employ the material in a graphene composite to improve strength and lightness.

There's much, much more to come, according to Ferrari. "In an ideal world, graphene is indeed an extremely exciting and exceptional material, with a lot of properties, thermal, mechanical, optical and so on, that are really beyond what most of the existing materials can provide." He cites working prototypes of mobile phones and panel displays with flexible touch screens as some of the best emerging technologies.

In fact when you ask an expert like Ferrari why graphene is surrounded by so much buzz, the superlatives start flowing faster than you'd expect from an academic: "It's the strongest material in existence, stronger than diamond, it's the material with the highest thermal conductivity, so it can dissipate heat better than any other material existing. It's a material where the electrons and the charge carriers are quicker than most other materials. It's the only material that can interact

However, delivering on the real promise of graphene is what keeps Ferrari busy in the part of eastern England known as Silicon Fen. It's not that it's hard to make either: "The easiest way to make it is to just to take a pencil and trace a line on a piece of paper, a small fraction of what you leave behind will be graphene," smiles Ferrari. Graphene is essentially a very large molecule of carbon, with each carbon atom connected to three other carbon atoms, forming a lattice of hexagon shapes. It's an atomic structure with unique properties of conductivity and strength

Scaling up and making it on an industrial scale that companies can use across their product ranges is the challenge. Ferrari takes up the story: "There are two main ways of making graphene. One is taking graphite and applying some solvent or water or whatever you like, shaking it in a solution, and creating an ink or a dispersion, and then once you have this ink you can print it, place it in a composite, so on and so forth."

"The second approach is similar to what the traditional semi-conductor industry is already doing, so you basically deposit atom by atom the graphene layers using a gas, typically methane, and then you can make some monolayers of graphene over a substrate in a large area."

Where the material is touted as a having the potential for massive impact is in the world of batteries which, as every smartphone, tablet and portable computer user knows, is an area that still holds plenty of room for improvement.

It also has interesting applications in architecture too. A concrete product that included graphene would not tend to get dirty over time, and adding graphene to materials in road tunnels would see the graphene molecules decompose harmful gases into less toxic ones.

Graphene is not alone, stresses Ferrari, who says there are over 500 known materials with a layered structure that can have useful properties to make what he describes as 'novel materials, not present in nature'. However they "are at a much earlier stage of investigation," so don't expect to see them in your local store too soon.

The issue for the moment is that innovations in materials need to be cheap and really disruptive to existing technology, and they have to pass a wide range of tests in order to be deemed safe to go to market.

To the explorers like Ferrari at this new frontier in materials, graphene is clearly set to change what we make and how well it performs. But we all need patience, as Ferrari concludes: "People don't seem to make a distinction between something like Facebook, a software developed at university and widespread after a few years, and something in hardware, or materials, that unfortunately can require decades of development to transition from lab to fab."

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