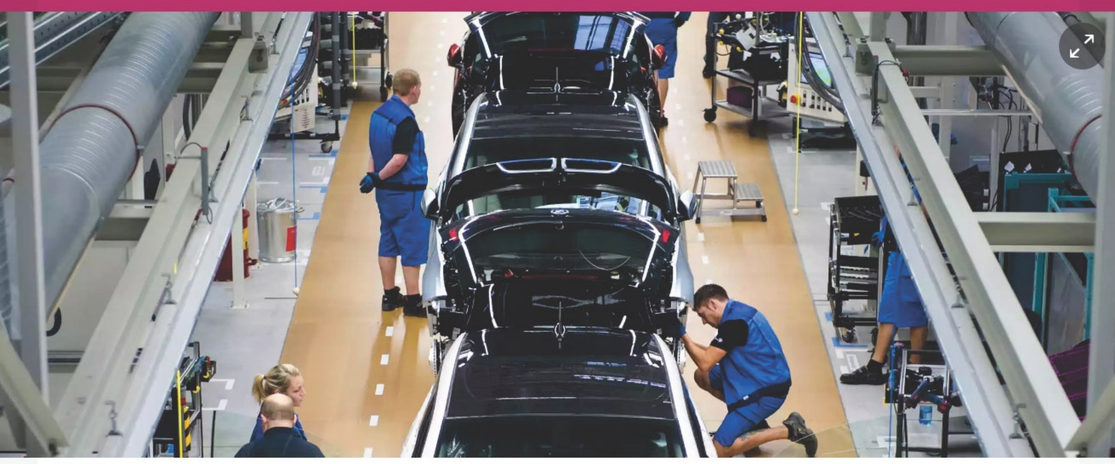
Carbon fibre: the wonder material with a dirty secret

Researchers are scrambling for ways to get the strong, light material out of landfill and make it ready for recycling and reuse



Workers in Leipzig assemble a BMW i3 electric model, the first mass-produced car with a carbon fibre passenger cell. Photograph: Jens Schlueter/Getty

Mark Harris

Wednesday 22 March 2017 05.00 GMT

Carbon fibre is increasingly celebrated as a wonder material for the clean economy. Its unique combination of high strength and low weight has helped drive the wind power revolution and make planes more fuel efficient.

Carbon fibre turbine blades can be longer and more rigid than traditional fibreglass models, making them more resilient at sea and more efficient in less breezy conditions.

Auto makers are also waking up to the material's potential to make lighter and more efficient vehicles. McLaren recently announced plans to open a factory in Sheffield to manufacture carbon fibre sports cars, and BMW's i3 is fitted with a carbon fibre passenger unit - the first such mass-produced car.

But carbon fibre has a dirty secret: the hi-tech material is wasteful to produce and difficult to recycle.

Excess waste for landfill

To become the strong, light composite material industries love, carbon fibre is combined with a plastic polymer resin. But the manufacturing process, in which sheets of composite material are often laid up by hand, is wasteful.

By the time they've been trimmed to size, almost a third of these carbon fibre sheets end up on factory floors, according to recycling company ELG Carbon Fibre. Where the material does make it into products, most of it will ultimately end up in landfill, the firm says.

A report (pdf) in February from the environmental charity Green Alliance listed carbon fibre as one of several novel materials that could create waste problems in the future unless swift action is taken to make it ready for recycling and reuse.

Researchers and startups are racing to solve this conundrum. If they can divert carbon fibre from landfill, they could open the gates for use of recycled carbon fibre in cars, bikes and for dozens of other applications. They could also save a lot of energy since the production of virgin material is the most energy-intensive part of the process.

The key problem is that carbon fibre cannot simply be melted down and reformed like aluminium. Carbon fibre composites get their strength from long, precisely aligned carbon fibres, fixed within a glue-like polymer that is cured at high temperatures and pressures. Once cured, most of these tough polymers will not melt and have to be burned off or chemically dissolved to reclaim the valuable fibres.

In its facility near Dudley, west Midlands, ELG Carbon Fibre has been recycling carbon fibre since 2009 by burning off the polymers. Vartega, a startup based in Colorado, which is emerging as a carbon fibre tech hub, does something similar with chemicals.

Both result in fibres that are shorter and more jumbled up than new ones, reducing their ability to bear heavy loads, says Steve Pickering, head of mechanical, materials and manufacturing engineering at the University of Nottingham.

Recycled carbon fibre often ends up in tennis rackets and golf clubs, where low weight (and the cachet of carbon fibre) is more important than strength, says Pickering. "It's still a good material but it's not that much better than other cheap materials out there like aluminium and other composites," he adds.

Future of carbon fibre

Pickering's research team is working on a way to disperse recycled fibres in liquid and realign them by forcing it through a tiny nozzle. He thinks the process will ultimately lead to recycled carbon fibre that is strong enough for automotive use.

More efficient recycling could have big implications for cost too, he says. As a material for car parts, carbon fibre currently costs 20 times more than steel and 10 times more than aluminium, according to research (pdf) from Jaguar Land Rover.

Chris Kaffer, CEO of Colorado-based Mallinda, a startup working on carbon fibre, agrees there is scope to bring down costs. The company has developed a new polymer that can be remoulded and repaired at lower temperatures and - because it is easy to reshape - would allow carbon fibre car parts to be stamped out in less than a minute rather than the several hours the process can currently take.

"We envision dropping the cost of carbon fibre by creating a secondary market for the incorporation of recycled fibres into new products," says Kaffer.

That will not happen overnight. The major car makers have in the past proved slow to embrace new materials: changing the F-150 pickup's chassis from steel to aluminium, for example, took Ford six years and cost a billion dollars.

"Plus, we have 50 years of traditional carbon fibre chemistry and development to catch up with," says Kaffer.

The good news is that carbon fibre products last a long time: the current generation of wind turbine blades and electric vehicles won't be heading to the wrecking yard for at least another decade. Perhaps by the time the second generation retires, we will have somewhere better to put their precious carbon fibres than a hole in the ground.