Making vehicles safer

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A car's crash components can spell the difference between life and death. Their job is to absorb energy in a collision in order to protect the driver inside. Researchers have now found a way for the automotive industry to mass-produce a particularly safe class of materials known as thermoplastic fiber composite components.

Vehicles used to be predominantly made of steel. However, this raw material has long faced stiff competition from other materials, and modern cars are now built from a mixture of steels, aluminum and fi ber-reinforced plastics. Highly stressed load-bearing structures and crash components that are designed to buckle on impact help to reinforce the body in order to protect the vehicle‘s occupants in the event of a collision. Automakers have previously constructed these parts from composites using a thermoset (i.e. infusible) matrix. But this approach has a number of disadvantages: as well as being diffi cult to implement efficiently in a mass production environment, it can also be potentially hazardous since this material tends to »delaminate« into sharp-edged splinters in a collision. A further problem is the fact that thermosets cannot be recycled. Researchers from the Fraunhofer Institute for Chemical Technology ICT in Pfinztal have now found a solution to this problem by developing a new class of materials designed for large-scale use in vehicle construction: thermoplastic fiber composite materials. Once they have reached the end of their useful life, they can be shredded, melted down and reused to produce high-quality parts. And they also perform significantly better in crash tests: thermoplastic components reinforced with textile structures absorb the enormous forces generated in a collision through viscoelastic deformation of the

matrix material - without splintering.

Researchers had previously failed to come up with a suitable manufacturing technique for thermoplastic composite structures made from high performance fibers, but the ICT engineers have now developed a process suitable for mass production which makes it possible to manufacture up to 100,000 parts a year. "Our method offers comparatively short production times," states Dieter Gittel, a project manager at ICT. »The cycle time to produce thermoplastic components is only around five minutes. Comparable thermoset components frequently require more than 20 minutes."

The Fraunhofer researchers have named their technique thermoplastic RTM (T-RTM). It is derived from the conventional RTM (Resin Transfer Molding) technique for thermoset fiber composites. The composite is formed in a single step. "We insert the pre-heated textile structure into a temperature-controlled molding tool so that the fiber structures are placed in alignment with the anticipated stress. That enables us to produce very lightweight components," Gittel explains. The preferred types of reinforcement comprise carbon or glass fibers, and the researchers have also developed highly specialized structures. The next step involves injecting the activated monomer melt into the molding chamber. This contains a catalyst and activator system - chemical substances that are required for polymerization. The ingenious part is that the researchers can select the system and the processing temperature in a way that enables them to set the minimum required processing time.

A demonstration part has confirmed the benefits of this new class of material: the trunk liner for the Porsche "Carrera 4" weighs up to 50 percent less than the original aluminum part. To improve the crash behavior of the vehicle's overall structure, the ICT engineers also calculated the optimum fiber placement. Another advantage of the T-RTM process is that the cost of the thermoplastic matrix material and

the cost of its processing are up to 50 percent lower than the equivalent costs for thermoset structures. Over the next few years it is anticipated that these kinds of components will start to be used in vehicle and machine construction as well as in the leisure industry. Experts in the field will be exhibiting the trunk liner for the Porsche "Carrera 4" at the COMPOSITES EUROPE fair in Essen from June 14 - 16 (hall 12, stand C33).

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