Media release

Materials Science & Technology

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Empa-«Technology Briefing»: Fiber-reinforced composites

Heavy going without lightweight materials

Automobiles made of steel suffer from a weight problem, and racing yachts made of steel have no chance of winning regattas. Fiber-reinforced composites offer an alternative which has spread rapidly in the transport industry. Empa's «Technology Briefing» offers an overview of the current situation and a preview of future developments.

Those who take an interest in innovation in the automobile industry might have thought that BMW and VW would have a head start in the use of carbon fiber structures in their vehicles. Last year both companies purchased shares in the supplier SGL Carbon. The competition hasn't been asleep, though, and companies like Daimler AG are hard on their heels. The car manufacturer based in Stuttgart has entered into a joint-venture with Toray Industries, the carbon fiber producer. Jan Krueger, of Daimler's Research and Advanced Engineering division, is convinced that the victorious march of fiber-reinforced composite materials will continue unabated. The advantages are easy to see: the new materials are lightweight, with good crash properties and noise and vibration reducing characteristics. Daimler has accumulated a lot of experience in lightweight construction techniques using fiber-reinforced composites with its Mercedes SLR McLaren Supersport car. Two and a half thousand examples of the noble racing car have come off the conveyor belt, and in the meantime the new technologies involved have fed into the mass production lines. From summer 2012 the boot lid of the SL 63 AMG Sport Coupé will be made using fiber composites. Already 140,000 front axle leaf springs are manufactured every year for the Mercedes Sprinter using composite materials, and every second seat heating system built into cars made in Stuttgart boasts heating elements made of carbon fiber.

Crash simulation

Peter Fritzsche of the University of Applied Sciences of Northwestern Switzerland reported on the simulation of break and crash tests with fiber-reinforced composites materials. Although the complex and nonlinear behavior of these materials often produces surprising results, computer simulation of the characteristics has already enabled considerable progress to be made. The more accurately the plastic deformation of the composites can be modeled, the more precisely can components made of composites be designed for a specific application.

Mass production at minimum cost

The views of a large manufacturer with thousands of employees worldwide were presented by Wenzel Krause of Autoneum, formerly the automotive division of the Rieter company. Autoneum supplies car manufacturers in North and South America, Europe and Asia with carbon fiber composite components which are used in the engine wells, underbodies, passenger compartments and boots of their vehicles. In doing so, Autoneum uses and delivers some one hundred thousand tonnes of the material annually. High stiffness and impact resistance are characteristics particularly demanded of materials used for underbody protection, naturally at the lowest possible cost. The company utilizes various production methods to manufacture components with exactly the required properties. Glass fibers cut to various lengths are used to reinforce the components in specific ways. The highest possible degree of automation is absolutely essential in mass production applications.

The next Alinghi

Carbon fiber-reinforced composite materials have already been used for some time in special high-value applications, such as that field of non-plus ultra yacht construction, the America's Cup. Andreas Winistoerfer with his company CarboLink GmbH (and Empa spin-off) designs stays and ropes for these yachts. Money is of secondary importance, but if a component should fail this is seen all over the world by millions of viewers. Winistoerfer has been in this demanding business for 10 years now. In addition to items for yachts, CarboLink also supplies the crane manufacturer Liebherr with high-tech guys of carbon fiber. The industrial partner profits from a 50 to 70 per cent weight reduction and, thanks to improved fatigue characteristics, a lifetime of up to 15 times longer for the carbon fiber component compared to that of steel.

Fibers with liquid content

Empa's «Rheocore» project is dedicated to creating improved tailor-made properties of composites materials by spinning fibers which contain branched channels of liquid. The aim is to create fibers which are flexible when bent slowly but react stiffly to rapidly acting forces. This effect could be used to create a new type of protective clothing which would be more comfortable to wear than anything available today. However the production of these liquid chambers in the fiber is anything but trivial, explained Rudolf Hufenus of Empa's Advanced Fibers Laboratory. In the meantime the project team has established the mathematical foundations of the effect and completed modeling trials. The next step is the manufacture of a first prototype of the spinning nozzle.

Further information

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Empa's Advanced Fibers Laboratory is researching and developing active, liquid filled fibers in the «Rheocore» project.

Text and images in electronic form are available at: redaktion@empa.ch