Lightweight construction on the way to volume production

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With the new system approach, CRP components can be produced „in assembly-line fashion.“ Credit: Fraunhofer ICT

Carmakers and airplane manufacturers are very particular when it comes to the weight of their models: the lighter they are, the less fuel they consume - and the less carbon dioxide they blow into the air. If a car loses 100 kilograms, depending on the type and driving style, it can save anywhere from 0.3 to 0.6 liters of fuel per 100 kilometers traveled. It also means a reduction of 7 to 12 grams in carbon dioxide emissions for each kilometer.

New materials, joining technologies and lightweight-construction concepts will help cars lose weight. Particularly promising are the carbon-fiber-reinforced plastics, or CRP for short: they are roughly 60 percent lighter than steel and around 30 percent lighter than aluminum. The

material also never rusts and can be used to construct crash-relevant structures such as body components. These materials get their stability from carbon fibers embedded in the plastic matrix. Depending on the demands, the fibers can be superimposed over several layers and in varying directions. A large share of the components found in aircraft and Formula One racers are already made of CRP. Producing the components using reinforced plastic is still quite an effort, however – many worksteps still have to be performed manually, and even the automated steps often have to be reworked by hand. BMW is now taking a major step forward with its new model I3, which will roll off the assembly line in 2013 with a body almost entirely made of CRP.

72 companies, educational institutions and research institutes, together with supporting organizations in the Munich-Augsburg-Ingolstadt area, have joined forces to create the MAI Carbon Leading-Edge Cluster Initiative to get carbon-fiber-reinforced plastics in shape for mass production. The cluster is one of the winning entries in the Leading-Edge Cluster Competition sponsored by the German Federal Ministry of Education and Research BMBF. The initiative is funded with 40 million euros from the BMBF, with another 40 million euros contributed by industry. A key partner in the cluster, along with Audi and BMW, is the Fraunhofer project group “Functional Lightweight Design FIL”. The project group was established in 2009 as a branch operation of the Fraunhofer Institute for Chemical Technology ICT in Augsburg. With funding from the State of Bavaria, the project group is expected to develop into an independent Fraunhofer Institute in the years to come. “Our goal is to reduce the manufacturing costs of CRP components by 90 percent over the five years of the project. We intend to accomplish this primarily through new production methods that are also well-suited for volume production,“ notes Prof. Dr.-Ing. Klaus Drechsler, head of the Fraunhofer project group and holder of the Chair in Carbon Composites at the Technische Universität München. Prior to his current appointment, Drechsler worked for several years at Daimler-Chrysler,

before transferring to the Institute of Aircraft Design in Stuttgart.

The researchers in Augsburg have already developed a new production method for the automobile industry. The method combines a braiding machine of the kind typically used in the textiles industry with a pultrusion system further developed by the Fraunhofer Institute for Chemical Technology ICT. The braiding machine gives the dry carbon fibers the right form, and the pultrusion machine covers them with resin. The special thing about this method: up until now, everything had to be performed by hand – fibers placed in the tool and lined up and the resin injected – but now all of these steps are fully automated. Made by hand, the individual components could only be produced step by step, with all components of a certain length. The combination system, on the other hand, produces the components continuously, so the parts it can produce could theoretically be infinitely long. Sponsors for the project are BMBF; development partners are Audi and Voith, a mechanical engineering firm.

The Fraunhofer project group has quite a bit to offer the aviation industry as well: among other things, together with colleagues from Premium Aerotec and Eurocopter, researchers there are developing a fully automated production method for large-scale CRP components. The core of the technology is a robot with a laying head: It picks up the resin-coated carbon fibers and lays them on the tool, where the fibers are then hardened. This step has been performed by hand until now – an elaborate undertaking resulting in lots of scraps and quality levels that are not always optimal. The automated process, on the other hand, is well-suited for volume production and delivers good and constant quality. And it doesn‘t generate any scrap, either – not a millimeter of fiber is wasted. The robot is currently working day and night in the laboratory in Augsburg. The components it produces are inspected at Airbus. “The method has a good chance of being adopted in series production of aircraft construction, which will begin in around two years,“ Drechsler is

pleased to report. The project is sponsored by the German Federal Ministry of Economics and Technology BMWI within the framework of research programs in aviation. The project volume is far in excess of one million euros.

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