The right material in the right place

Hybrid lightweight construction for optimum component design

Frankfurt, September 27, 2016 – Lightweight construction will be a key topic at Composites Europe in Düsseldorf from November 29 to December 1, 2016. The trade fair focuses on hybrid lightweight construction solutions made from a smart mix of materials.

The automotive industry is under enormous pressure. It will have to drastically reduce vehicle emissions in order to meet the low CO₂ limits set by the EU. In addition to more efficient motors, this goal will primarily be achieved by reducing vehicle weight – so lightweight construction is the order of the day. The need to make lighter bodies has led to the development of composites, primarily carbon fiber reinforced plastics (CFRP), which have enjoyed rapid and very successful progress over the last few years. Although much lighter than metals, the materials are still very strong.

The body of BMW’s i3 is made entirely from CFRP. Like the Audi A8, whose body is nearly 100 percent aluminum, this example shows what technology is capable of. But just as the A8 has not caused steel to disappear from car bodies, there is no prospect of all being cars made from CFRP in the future. The experience gained from earlier developments suggests that, in the future, there will be an effective mixture of materials such as CFRP, plastics, steel, aluminum and magnesium. Hybrid lightweight construction will shape the future of cars. These developments will also benefit other sectors, such as the aerospace industry and electrical engineering.

“There will be increased competition between materials and material combinations, but I do not foresee one replacing the other,” says Marc Kirchhoff from sector management for lightweight design and electromobility at Trumpf Laser- und Systemtechnik GmbH. After all, he says, it was the steel sector itself that began searching for lightweight solutions after the development of the Audi A8. Tailored blanks – tailor-made sheets of various shapes, thicknesses, and strengths that are now used in cars regularly – were one result. Even the development of high-strength steels is the result of the competition between materials. Kirchhoff expects this development to be repeated now that plastics and hybrid components are entering the running.
Steel manufacturers will try to develop even higher-strength steels, and aluminum manufacturers are doing the same. The competition between the various materials is pushing everyone to achieve more. No technology has yet fallen behind,” says Kirchhoff with conviction.

The B-pillar as a textbook example

As the side connection between the vehicle floor and roof, the B-pillar must be extremely strong and meet very stringent crash requirements. This sophisticated component is still made from relatively thick steel in most cars, but competition from other materials is growing. “I can certainly imagine it being made from fiber reinforced plastic in future. As well as its high strength-to-weight ratio, the key advantage of a fiber reinforced structure is its high energy absorption in the event of a crash,” says Nicolas Beyl, Managing Director of Reaction Process Machinery at KraussMaffei Technologies GmbH.

Increasing safety for the vehicle's occupants has always been a huge goal for designers, who now have various ways to make this happen. “Developments are under way to select materials appropriate for the loads along the B-pillar. Combinations of steel, high-strength steels and plastics will be used here. Such a B-pillar offers the highest possible level of safety and is also much lighter than a purely steel construction,” explains Kirchhoff. The well-known B-pillar thus sets the tone for a development that is found throughout the vehicle. In the future, engineers will consider which material is best suited for each individual application: CFRP, glass fiber reinforced plastics, aluminum or steel.

Another parallel to the Audi A8 from the 1990s is this: Although bodies made completely from aluminum did not become standard in all vehicle classes, more and more parts of the hood, fenders and sometimes even doors are now made from aluminum. In the same way, the BMW i3 will trigger greater use of composites in cars. “Areas of the car in which fiber reinforced plastics dominate will establish themselves, while aluminum or steel will dominate in other areas,” says Beyl.

The challenge of bonding technology

The key to the future mix of materials is bonding technology. There have long been established joining methods for components made from the same material. Steel sheets, for example, are welded together. However, different materials cannot be bonded using the usual approach, which is also why the passenger compartment of the BMW i3 is made completely from CFRP. Using this new material in a product ready for production was challenge enough to begin with, so little effort was made to solve the issues relating to bonding one material with another. A fiber composite cannot be welded with a sheet structure, which is why processes for adhesion, rivet or screw attachment were developed.

One tool for hybrid bonds is the laser. “This provides many options for processing various materials, such as cutting, texturing and much more,” says Kirchhoff. Bonding technology is one of the central topics being discussed by the VDMA Hybrid Lightweight Technologies working group. This platform makes it easier to exchange experiences and improve the connection between end users, suppliers and mechanical engineering companies. The goal is to develop a mix of technologies in joining technology for the material mix of hybrid
lightweight construction. “Since we in the working group represent the complete spectrum, it is easier to identify the requirements of the market. After all, the goal is to make the very best of things and examine everything without blinders,” says Peter Egger, Head of the Technology Centre for Lightweight Composites at the injection molding company Engel Austria and chair of the new working group.

Mix of materials to shape the car of the future

As a specialist in forming technology, the press manufacturer Schuler has a good overview of which materials are gaining traction in vehicle production. “We are seeing rapid growth in hot forming at the moment. There are now more than 300 plants worldwide, and the trend is continuing. Composites are still a minor player in comparison, but their importance is growing. Now we see all vehicle companies dabbling in them,” says Lothar Gräbener, Director of Sales in the Hydraulics, Sheet Metal Forming and Lightweight Construction division at Schuler.

Even the steel industry is making moves towards lightweight construction. For example, the industry has developed hot-stamped high-strength steels in an effort to reduce weight. Here, a particular steel alloy is heated to a high temperature before being fed to the forming press, where the steel is then allowed to cool. This causes a structural transformation that makes the material significantly stronger. As a result, thinner, and thus less, material can be used for the same application.

“We believe that there will be more and more multi-material vehicles in the automotive sector,” says Gräbener. New high-strength steels will be incorporated, as will aluminum and magnesium, not to mention the pure plastics and composites. “There are many new developments here. As well as carbon and glass fibers, natural fibers such as rapeseed are already being used. The race between materials continues,” says the expert on presses.

There is no way the automotive industry can avoid lightweight construction – and not just because it has to meet the political targets for emission reduction. Lightweight construction is essential in the development of electric cars, because the substantial weight of the batteries has to be offset by weight reductions in other areas. “We will therefore be seeing ever more lightweight applications. This is not limited to fiber composites, but can also be lightweight metal structures. I foresee a bright future for mixed structures that are able to implement this kind of solution at a lower cost,” says Matthias Graf, Head of Technology and Business Development – Business Unit Composites at Dieffenbacher GmbH.

This overview of lightweight construction focuses on hybrid lightweight construction, the primary aim of which is to usefully combine composites with aluminum, steel and other materials. Hybridization is one of the key topics at Composites Europe. This article is the second of a short series on lightweight construction. The first was about the development and use of composites. Both articles can be accessed at www.lightweight.vdma.org
On January 22, 2016 VDMA’s Forum Composite Technology was transferred into the Working Group Hybrid Lightweight Technologies. This expands the field of activity by metallic lightweight construction to produce hybrid lightweight construction. Alongside the 180 VDMA member companies, collaboration in the Working Group is now also open to users, suppliers and researchers. Their shared goal is to develop production processes, automation and joining technologies further across materials and throughout Europe, thus creating jobs for the future.