Case Study
Vehicle front-end structure produced using PMH technology and over-molded composite plastic sheet

Figure 1  The lower beam of the front end features a U-shaped profile made of composite plastic sheet.

The plastic-metal hybrid technology invented by LANXESS, also known as PMH technology, has become firmly established in the automotive industry for the manufacture of lightweight, high-strength structural parts such as front ends, pedal support brackets and brake pedals. Previously, steel or aluminum sheet was used as the metal component.

Now, for the first time, engineers have succeeded in designing a PMH front end for the new Audi A8, using not just sheet metal, but also thermoformed glass-fiber composite sheets. A U-shaped profile made from these composite sheets is overmolded with plastic to form the lower beam of this part (fig. 2).

This front end proves that nylon composite sheet can meet all of the requirements relating to torsional and flexural strength. It is an excellent alternative to steel and aluminum sheet in PMH technology.

Figure 2 Detail of the nylon composite sheet reinforcement for the lower beam

LANXESS supplies tailor-made polyamide 6 grades from its Durethan product line not only for producing the nylon composite sheet but also for overmolding the reinforcing ribs and molding-in functional features.
The nylon composite sheet is produced by Bond-Laminates GmbH in Brilon, Germany.

These composite sheets are produced using thermoplastics (in this case with polyamide 6 as the matrix) reinforced with continuous fibers. Because of their high strength and stiffness combined with low density, they make outstanding lightweight construction materials. To manufacture a hybrid component, the nylon composite sheet is first heated, formed and trimmed. The part is then placed in an injection molding tool and strengthened with ribbing or reinforcements made, for example, of polyamide 6, thus forming a material bond. Together with a number of its partners, LANXESS is currently working on transferring the previously separate forming step into the injection mold, so that the forming and injection processes can be carried out in a single operation for greater cost-effectiveness and productivity.

The nylon composite sheet reinforcement for the lower beam (aluminum sheet is used for the upper beam) is just 1.0 mm thick. When the car is out on the road, the part is subjected to considerable loads because the lower beam carries, among other things, pedestrian protection components, the bumper, the underbody protection and the cooling module attachments. Despite this, it was possible to design the U-shaped composite profile thinner than with aluminum sheet.

Easy-flow Durethan® BKV 30 EF (polyamide 6) reinforced with 30 percent glass fibers is used to injection mold the hybrid front end. It can be processed with injection pressures that are up to 40 percent lower than with comparable standard grades of polyamide 6. This means less mold wear and therefore lower mold maintenance costs. Apart from that, walls can be made thinner, and finely structured geometries can be reproduced more accurately. Additional savings come from lower injection temperatures (less energy consumption, faster cycle time). Furthermore, fewer gates are needed, which helps to achieve uniform orientation of the glass fibers and thus minimize shrinkage and warpage.

As with earlier PMH front ends, many functions are integrated into the front end of the Audi A8, which considerably simplifies subsequent assembly and the logistical operations connected with it. Such functions include attachment points for the radiator, crash sensor, oil cooler air scoop, headlamps and headlamp bezels. Threaded bushings and the connections to the fender carrier and the bumper skin are also integrated.

LANXESS provided its partners with comprehensive support in developing the front end. For example, mold filling analyses were carried out to minimize component warpage and achieve optimum filling of the mold. Furthermore, the torsional and flexural behavior of the nylon composite sheet carrier were tested to validate the simulation of its crash behavior. When simulating the design of the part, it was a big advantage that LANXESS already had the mechanical data for both the nylon composite sheet and the easy-flow polyamide 6 that is used as the other component in the injection molding process. Finally, the company’s experts were also able to give assistance with tool try-outs and production start-up.
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Note:
The information contained in this publication is current as of July, 2010. Please contact LANXESS Corporation to determine if this publication has been revised.