Case Study

Front end produced by hybrid technology with nylon composite sheet

OEM: Audi

Grade: Durethan® BKV 30 H2.0 EF, Nylon composite sheet

Fig. 1 The lower beam of the front end features an U-shaped profile made of nylon composite sheet.

The plastic-metal composite technology invented by LANXESS, also known as hybrid 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 succeeded in designing a hybrid front end for the new Audi A8, using an nylon composite sheet: An U-shaped profile made from the lightweight material reinforces – besides an aluminium sheet - the lower beam of this part (fig. 2).

This front end proves that nylon composite sheet meets all the requirements relating for instance to torsional and flexural strength. It is an excellent alternative to steel and aluminum sheet in hybrid technology.

LANXESS supplies tailor-made polyamide 6 grades from its Durethan range not only for producing the nylon composite sheet but also for injection molding the hybrid front end.

Fig. 2 Detail of the nylon composite sheet reinforcement for the lower beam

The nylon composite sheet is produced by Bond-Laminates GmbH in Brilon, Germany.

These are 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, the lower leg protection, the bumper, the underbody protection and the fixing point for the cooling module. Despite this, it was possible to design the U-shaped 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 (energy consumption, cycle time). Furthermore, fewer gating points are needed, which helps to achieve uniform orientation of the glass fibers and thus minimize shrinkage and warpage.

As with earlier hybrid front ends, many functions are integrated into the hybrid front end of the Audi A8, which considerably simplifies subsequent assembly and the logistical operations connected with it. Such functions include fixing points for the radiator, the crash sensor, the air scoop for the oil cooler and the headlamp and its bezel. Also integrated are threaded bushings and the connections to the fender carrier and the bumper skin.

LANXESS provided its partners with comprehensive support in developing the front end. For example, mold flow 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 mold proving and production start-up.