Case Study

Brake pedal in polyamide composite sheet hybrid technology

50 percent reduction in weight

Fig. 1 Pedal box with all-plastic clutch pedal and brake pedal in polyamide composite sheet hybrid technology

Grade: Durethan® BKV 30 H2.0

Manufacturer: ZF Friedrichshafen AG, Germany

In cooperation with LANXESS and Bond-Laminates GmbH from Brilon, Germany, ZF Friedrichshafen AG has developed a brake pedal based on polyamide composite sheet and polyamide 6. The main advantage of this system over comparable steel pedals is a 50 percent lighter design with the same mechanical strength. Weighing just 355 g, this concept component is the world's first automotive brake pedal made of polyamide reinforced with continuous glass fibers that is suitable for mass production. This part is only one example of the numerous weight-saving opportunities being opened up by thermoplastic composite structures in the drive to Green Mobility. Composite brake pedals can be used not only in conventional passenger cars, but are also ideal for electric vehicles where weight must be kept to an absolute minimum to ensure maximum driving range.

A brake pedal in polyamide composite sheet hybrid technology is easier to manufacture than a comparable steel pedal, which usually consists of several sheet metal components. For example, this new technique eliminates the need for the complicated forming, cutting and welding processes required with sheet metal. Costly anti-corrosion treatments are also made obsolete due to the metal-free design.

The material used in the pedal outer shell is Tepex® Dynalite, a polyamide composite sheet from Bond-Laminates. The 2 mm thick material, reinforced with 47 percent continuous glass fibers by volume, is first heated, then thermoformed into shape and cut to size. The resulting insert is placed into the molding tool and over-molded at specific locations with Durethan BKV 30 H2.0 polyamide 6 resin. Further cost savings are possible by producing the pedal in a single-step process in which the composite sheet is formed directly in the injection molding tool prior to overmolding. Other cost advantages over an all-steel solution are due to the ability to directly integrate functional features during the molding process. Typical examples of functional integration with this application include the pedal foot plate, attachments for the booster rod, and components for the brake light switch.

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Polyamide 6 is used as both the injection molding material and the matrix of the composite sheet. In contrast to hybrid technology with plastic and sheet metal, the over-molded plastic forms a material bond with the composite sheet at all contact surfaces. This weld-like bond significantly increases the mechanical performance of the component and allows it to exceed the OEM's specifications for brake pedals.

LANXESS provided ZF with considerable support with the concept development and computer-aided engineering of the brake pedal. These services are part of the HiAnt® brand, in which the High Performance Materials (HPM) business unit has combined the know-how it has developed in materials, design, simulation and process technology to deliver tailored engineering services to our customers. For example, the forming process of the composite sheet was simulated in order to calculate local differences in fiber orientation. These results were combined with a newly-developed material model that accounts for the anisotropic material behavior of the composite sheet. This allowed material orientation to be optimized to best handle the applied loads. LANXESS engineers are even able to calculate more safety-critical properties of polyamide composite sheet hybrid parts, such as their crash behavior. As shown with this Brake Pedal, LANXESS's capability to provide advanced material models and CAE services to customers like ZF is making the next-generation of ultra-lightweight components possible.

GREEN MOBILITY™
ENERGIZED BY LANXESS

The ability to save weight in vehicles by using plastics such as Durethan®, Pocan® and Tepex® leads to increased fuel efficiency and the associated reduction in CO_2 emissions.

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