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

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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.

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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Regrind
Where end-use requirements permit, regrind may be used with virgin material in quantities specified in individual product information bulletins, provided that the material is kept free of contamination and is properly dried (see maximum permissible quantities and drying conditions in product information bulletins). Any regrind used must be generated from properly molded/extruded parts, sprues, runners, trimmings and/or film. All regrind used must be clean, uncontaminated, and thoroughly blended with virgin resin prior to drying and processing. Under no circumstances should degraded, discolored, or contaminated material be used for regrind. Materials of this type should be discarded. Improperly mixed and/or dried regrind may diminish the desired properties of a particular LANXESS product. It is critical that you test finished parts produced with any amount of regrind to ensure that your end-use performance requirements are fully met. Regulatory or testing organizations (e.g., UL) may have specific requirements limiting the allowable amount of regrind. Because third party regrind generally does not have a traceable heat history or offer any assurance that proper temperatures, conditions, and/or materials were used in processing, extreme caution must be exercised in buying and using regrind from third parties. The use of regrind material should be avoided entirely in those applications where resin properties equivalent to virgin material are required, including but not limited to color quality, impact strength, resin purity, and/or load-bearing performance.

Color and visual effects
Type and quantity of pigments or additives used to obtain certain colors and special visual effects can affect mechanical properties.

Note:
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