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Driving new lightweight and high strength solutions for the automotive industry

FEATURE

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DuPont is always investing in its materials and, through different partnerships, is developing exciting applications for its products. The BMW i8 sports car is a perfect example of this type of investment. It features a new resonator made of glass-fiber reinforced DuPont Zytel® PLUS 95G35. The resonator, developed in close collaboration between BMW Group, DuPont Performance Materials and MANN + HUMMEL, reduces the noise of the two turbo charged engines to allow for an even more pleasurable driving experience. The lightweight and high strength features of this material also allow for the reduction in fuel consumption and CO_2 emissions.

The need to reduce emissions while not compromising performance is the driving force behind new applications like this. Car manufacturers are continuously looking for alternatives as a response to the EU's target to reduce greenhouse gas emissions leading to significant changes to new cars in Europe. The targets oblige cars to emit no more than 95 g/km of CO_2 by 2021.

These environmental policy considerations mean there is a growing requirement within the automotive industry for cost-efficient, easily-processable thermoplastics that are able to reliably withstand the rigorous demands of the engine compartment or automotive exterior for the entire lifetime of the vehicle. One of the methods to restrict emissions is by turbo-charging engines – reducing the engine while maintaining the original power. However, a side-effect of shrinking the size of the engine is that the heat in the engine increases and thus industry was in need of elements for the powertrain system that are durable in high-heat, harsh-chemical environments.

DuPont was one of the first to address this tendency and the Zytel® PLUS grade was the first of its kind. Zytel® PLUS family is part of the company's lightweighting project to help manufacturers address these pressures. DuPont believe lightweight technologies reduce structural weight without compromising the product's durability and sustainability. These materials have proven to have a number of advantages, including reduced energy consumption, better design, improved usability and multifunctional attributes for complex industries such as automotive.

Development

Zytel® PLUS material is part of the original nylon material family – a product that has been part of DuPont's portfolio since its discovery in 1935. Nylon is one of the industry's most accommodating materials due to its balance of performance, cost and processing – boosting its performance for longer-life components, improving flow while maintaining ease of design and processability. For more than 25 years, glass fiber or mineral reinforced, heat- and hydrolysis-stabilized nylon 6 and 66 grades have been the

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material of choice for under-the-hood applications in the automotive sector. This is due in principle to their high levels of cost-efficiency and because, in contrast to many more expensive alternatives such as the specialty nylons 46, 6T and PPA or the high performance thermoplastics such as PEEK and PSU, they are easy to process, ductile and impact resistant.

Zytel® PLUS, one of the latest grades of the nylon family, provides even more superior temperature and chemical resistance for demanding automotive engines, drive train and cooling uses. This is a high temperature plastic that stands up to hot air, hot oil and hot water. It combines superior performance and great surface appearance with the high flow and ease of processability that nylon is known for. The Zytel® PLUS family comprises four chemical-, heat- and oil-resistant grades which are optimized depending on the targeted application, though it is more commonly found in the automotive industry.

The four grades of Zytel® PLUS nylon family are:

- Zytel® PLS95G35DH1 BK549 is the core and highly versatile products due to its outstanding properties even after long-term exposure to high air temperatures of up to 230 °C with very good surface quality and high resistance to hot motor oil and calcium chloride solutions.
- Zytel® PLS95G50DH2 BK 261 is a high-flow nylon with an increased glass fiber content of 50 percent. It combines very good resistance to the long-term effects of high temperatures up to 210 °C (short-term peaks of up to 230 °C) with increased stiffness and creep resistance at high temperatures, thus making it ideal for applications under-the-hood.
- Zytel® PLS93G35 DH1 BK549 offers a low melt temperature of 224 °C (all other grades: approx. 265 °C) and combines good long-term retention of properties when exposed to heat, oil and chemicals with very good weld line and burst pressure strength.
- Zytel® PLS90G30DR BK099 is notable for its outstanding resistance to hot engine coolant and hot water, and is ideal for the production of radiator end tanks, thermostat housings and other components that come into direct contact with coolants.

These new, highly-resistant nylons, which demonstrate mechanical properties over a wide temperature range and are as ideally suited to long flow distances as they are to low wall thicknesses, also offer new perspectives in the design of applications such as electric and electronic components, sanitary equipment or parts for industrial facilities. Development marks a successful increase in the thermal and chemical resistance of nylons to new levels. Their major benefits, in terms of their low specific weight, high-flow and therefore ease of processing at moderate temperatures way below their decomposition temperature, are fully retained.

Heat management

Using an exact combination of base material and additives, multifaceted benefits are delivered which, depending on the targeted application, meet resistance requirements far better than nylons commonly available today (Fig. 1). The efficiency of this technology is best illustrated by the microscopic images of two heat-stabilized, glass fiber reinforced PA66 grades. They show microtomed sections through samples with an initial thickness of 4 mm, which have been exposed to a temperature of 210 °C for 1,000 hours. The resulting damage to the traditionally-stabilized

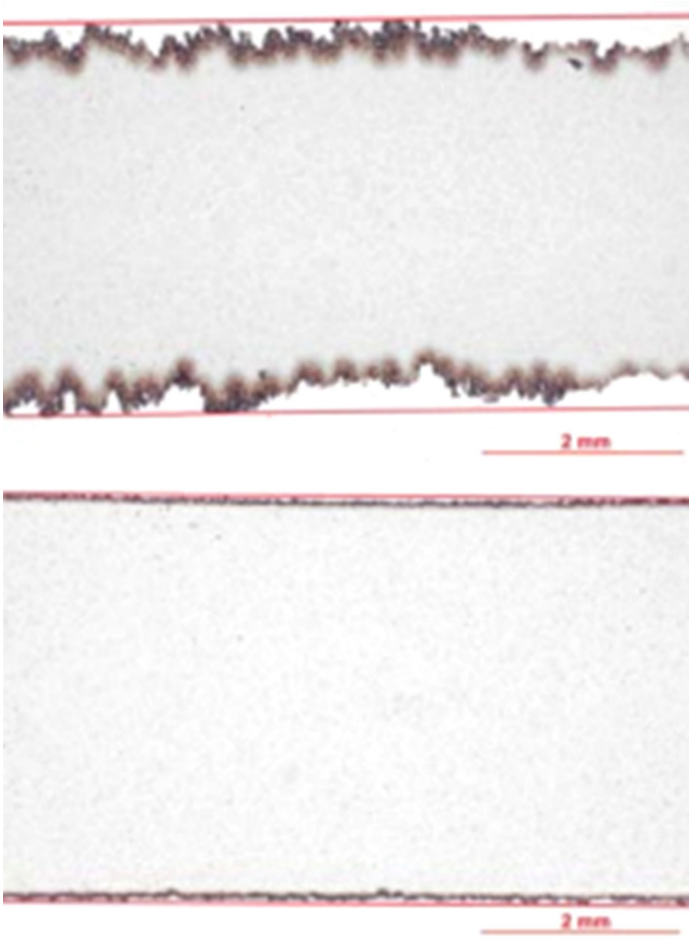

FIGURE 1

PA66 is shown in the image, the lower image shows a grade of Zytel® PLUS nylon, which has been stabilized with the new technology.

At an aging temperature of 180 °C, a traditionally stabilized grade would lose approximately one half of its tensile strength (a decrease from 210 MPa to 105 MPa) after 3,000 hours (the equivalent of around 150,000 km for vehicle applications), whereas the PLUS grade shows almost no sign of deterioration at the same temperature (Fig. 2). A comparison at an aging temperature of 210 °C, which is becoming more and more the decisive factor in the automotive industry, makes the difference even more clear. In this case, the standard grade has lost half of its tensile strength after approximately 800 hours, whereas the PLUS grade withstands this temperature for more than 3000 hours before its tensile strength is less than half of its initial value. At this stage, the standard grade is almost entirely carbonized.

An equivalent trend can be found in terms of strain at break. Whereas this property is already at almost half of its original value after 2,000 hours at 180 °C for traditionally-stabilized grades, the new Zytel® PLS95G35DH1 BK549 nylon shows little change in terms of its strain at break even after 3,000 hours. During air oven aging at 210 °C, the halfway point for the traditionally-stabilized grade lies at just under 700 h, whereas the Zytel® PLUS grade does not reach this point until after 2000 hours, and even after

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