Blends of PP and PA Reduce Weight and Improve Chemical Resistance

Lighter Together

Vehicle weight reduction requirements today pose great challenges not only to automotive manufacturers and suppliers but also to material producers. The materials used must cut weight while at the same time withstanding the mechanical and chemical stresses encountered in service. This can be achieved, for example, with blends of polyamide and polypropylene. These blends also offer other useful advantages.

Lightweight construction has been a key challenge for the automotive industry for years. Driven by legislative requirements to reduce vehicle CO_2 emissions, automotive manufacturers are developing cars with lower consumption values. Besides achieving this goal through various approaches in the areas of design, the engine unit, and drive technology, automotive manufacturers are demanding materials that can enable weight reduction, while still meeting the high requirements specified for engineering components. In the case of thermoplastics, the first material that comes to mind is polypropylene (PP). However, PP – unlike polyamide (PA) – cannot satisfy the requirements for highly stressed lightweight components on its own. A possible solution to this is offered by blends of PA and PP. A blend such as this from Akro-Plastic is already starting to be used in automotive industry projects and allows weight savings to be made in serial production components while providing acceptable technical performance.

PP has considerably lower density than the standard polyamides PA6 and PA66 widely used in automotive manufacture. Blends of PP and PA6 or PA66 therefore also have a lower density and consequently a lower weight. However, polyolefins such as PP and PA in purely chemical terms are not compatible. Problems such as delamination are therefore anticipated.

Stable Compound Obtained by Grafting and Special Compounding Technology

“The solution lies in using the right compounding component,” says Marc Ollig, Head of Global Product Management at Akro-Plastic. To this end, PP is grafted with a special chemical that enables it to chemically bond with PA. In this way, it is possible to obtain not just a purely mechanical bond but also a strong chemical bond. This process takes place during the compounding process. Gentle, reliable, reproducible compounding technology is therefore essential for a good end product. Akro-Plastic uses a kneading block-free compounding method based on the ICX technology it has developed in partnership with its sister company Feddem. Thanks to the gentle, kneading block-free screw geometry, the individual components can be reacted without

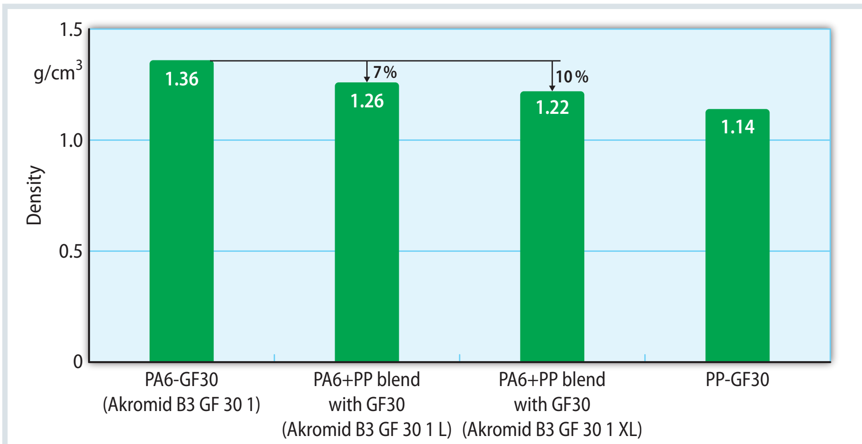

Fig. 1. Depending on the grade, PA6+PP blends with 30 % glass fiber reinforcement have a 7 to 10 % lower density than pure PA6 with the same glass fiber reinforcement. Although the density of PP-GF30 is even lower, this material does not usually fulfill the necessary technical requirements. Source: Akro-Plastic; graphic: © Hanser

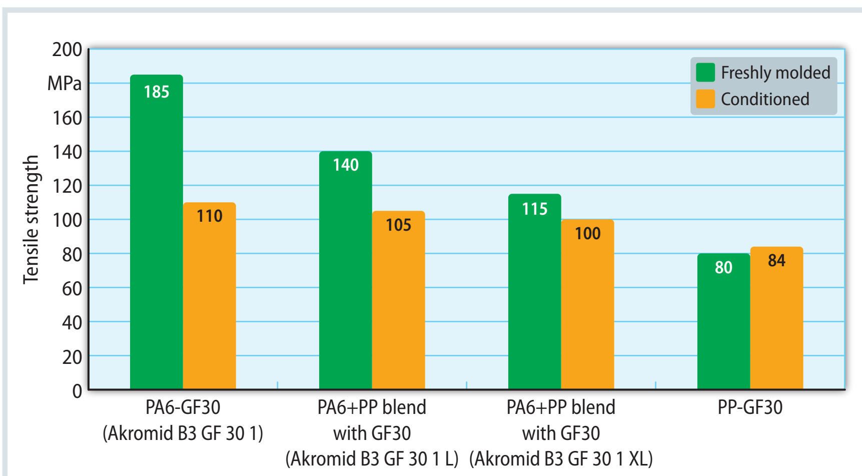

Fig. 2. The effect of conditioning upon tensile strength is less with the PA+PP blends than with PA6. Source: Akro-Plastic; graphic: © Hanser

impairment. The resulting blend has been given the name Akromid Lite.

Up to 10 % Lower Density

"Our aim in developing Akromid Lite was to produce a compound with similar properties to PA, without compromising its most important technical properties," explains Ollig. Depending on the PP content, the density advantage of the blend over pure PA is between approximately 7 and 10 % (**Fig. 1**). PP glass fiber blends (PP-GF30) are even lighter but the mechanical strength properties of PP compounds are often inadequate. In freshly injection molded materials, a considerable difference between the tensile strength of PA and PA blends can be seen. However, this largely evens out after conditioning. Overall, the percentage difference in the blends is less than with a pure PA6 compound. This gives designers a greater safety margin in part design (**Fig. 2**).

Depending on PP content, the heat deflection temperature (HDT) of the PA+PP blends is only slightly below that of pure PA. At the same time the HDT of the blends is considerably higher than that of PP compounds. Consequently, the blends are suitable for use in technical components that were once the domain of PA (**Fig. 3**).

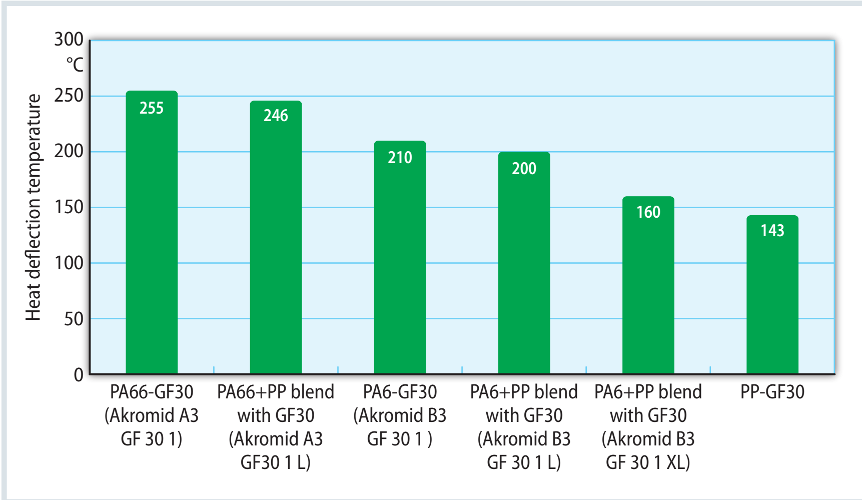

Fig. 3. Due to the PP content of the blends, their heat deflection temperature is sometimes lower than that of pure PA. However, the difference is minimal and so they are still suitable for heat-stressed components. Source: Akro-Plastic; graphic: © Hanser

Practical Experience Demonstrates Success

Technical components are often exposed to a whole range of different chemicals during service. Although »

Fig. 4. Test bars after contact with a calcium chloride solution. The grey points indicate degradation. The bars made from the PA+PP blends show basically no degradation, unlike those made from PA. © Akro-Plastic

PA has inherently good chemical resistance, there are some substances encountered by automobiles in service that attack it to a greater or lesser extent. One such substance is calcium chloride ($CaCl_2$), which is often used as a road salt. In this capacity, it inevitably comes into contact with PA components. To test the compatibility of the polymer with $CaCl_2$, there are standardized methods which are frequently specified by automotive manufacturers. Any degree of degradation occurring can easily be determined visually. Increased surface greying is an indicator for the severity of degradation. In these tests, PA+PP blends have shown themselves to be very resistant to $CaCl_2$ (**Fig. 4**).

PA is, however, much more severely attacked by zinc chloride ($ZnCl_2$). This is formed by the chemical reaction of calcium chloride with zinc, for example on galvanized surfaces. $ZnCl_2$ can lead to failure of PA components. "Our polyamide/polypropylene blends are very resistant to zinc chloride. It would appear, the PP forms a barrier layer against it," explains Marc Ollig.

The combination of weight reduction without appreciable compromises in terms of mechanical properties, even at elevated temperatures, brings significant practical advantages. Taking the example of a fan shroud, it can clearly be seen through the use of PA+PP blends, component weight can be reduced to even less than that of a part produced by foam injection molding. Since the part can be manufactured by standard injection molding, no additional investment in machinery or tooling is necessary. If the PA+PP blend is used in foam injection molding, such as the MuCell process, component weight can be even further reduced (**Fig. 5**).

Twice as Sustainable

PA+PP blends make a two-fold contribution to sustainability. They reduce component weight and hence vehicle fuel consumption. In addition, they partly replace PA – with its less favorable carbon footprint – by the far more eco-friendlier PP. Consequently, the CO_2 footprint of PA6+PP-GF15 is about one-quarter less than that of PA6-GF15 (**Fig. 6**). ■

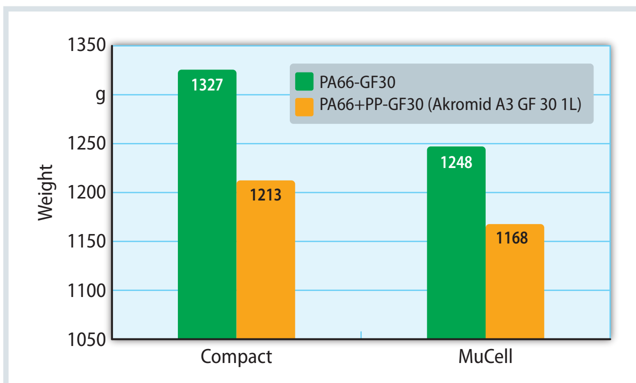

Fig. 5. With these blends, it is possible to produce compactly designed fan shrouds that are even lighter than those made by foam injection molding with pure PA66 for example. Source: Akro-Plastic; graphic: © Hanser

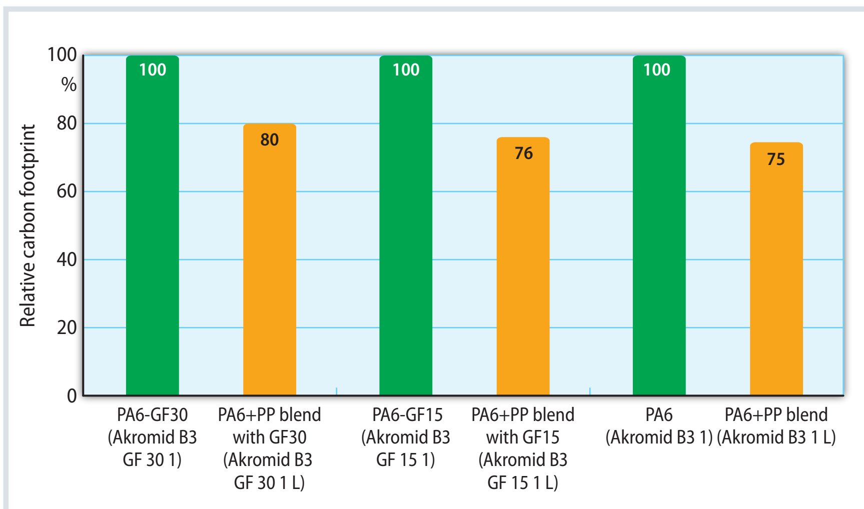

Fig. 6. Relative reduction of the carbon footprint by replacing conventional PA6 compounds with Akromid-Lite compounds: depending on the material, savings of up to 25 % are possible.
Source: Akro-Plastic; graphic: © Hanser

Info

Author

Manfred Bär has been working at Akro-Plastic in Niederzissen, Germany, since 2010 and is currently Business Development and Key Account Manager;
manfred.baer@akro-plastic.com

Digital Version

A PDF file of the article can be found at
www.kunststoffe-international.com/archive

German Version

Read the German version of the article in our magazine ***Kunststoffe*** or at
www.kunststoffe.de