Bio-Polyamides for Automotive Applications

A joint development project, which is partly funded by the German Federal Ministry of Education and Research (BMBF) and partly supported by the so-called BIOPRO Baden-Württemberg 'cluster', focuses its activities on bio-based polyamides for automotive applications and received two awards in 2009. In April, during the world renowned Hanover Fair, a group of scientists from companies such as Daimler, BASF, Bosch, MANN + HUMMEL and Fischer-werke, as well as the University of Braunschweig, received the '2009 VDI award for the innovative application of plastics'. This award acknowledges the first successful manufacture of an air filter system for Daimler, made from bio-polyamide and ready for series production. The air cleaner in question is supplied by MANN+HUMMEL. The partly (60%) biobased polyamide 6.10 used for the filter was supplied by BASF. Another award was presented to the team at MATERIALICA in October 2009 in Munich, Germany. Within the 'MATERIALICA Design and Technology Awards 2009' the group received the special 'Best of Material' prize for the same air cleaner. In addition to this achievement companies in the group succeeded in developing further automotive applications suitable for series production using 100% bio-based polyamide 5.10.

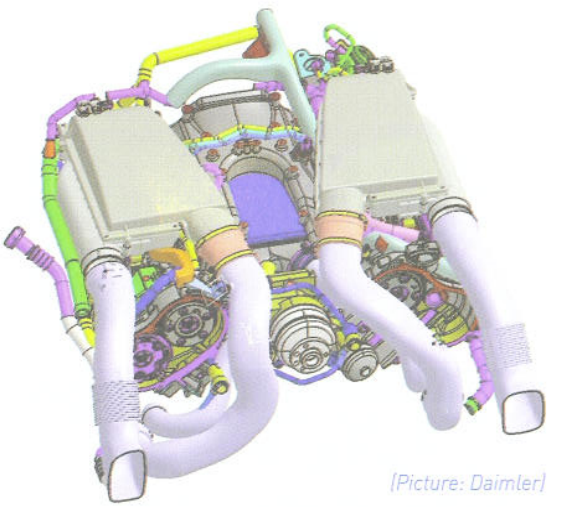
In the future biopolymers will also be able to be used for automotive components that are currently made from high performance plastics produced from fossil raw materials. To drive forward this integrated project the air filter, for the new Mercedes Benz engine, was for the first time produced from polyamide 6.10 and polyamide 5.10, establishing new milestones in future-oriented and ecologically friendly material applications technology. As in other branches of industry, market launches in the automotive industry will depend very much not only on the technological development of this innovative material but also on the way that the prices of bio-polyamides develop.

The air filter housing consists largely of three polyamide parts. The air intake tube and the clean air hood are screwed together. A top cover is bonded to the housing by vibration welding. The polyamide 6.10 which is used for the parts is produced from hexamethylenediamine and 60 percent by weight of bio-based sebacinic acid (from castor oil), and reinforced with 10% glass fibre and 20% mineral substances. Alternatively a totally bio-based polyamide 5.10 can be used. With this material both monomers are produced from renewable resources. In addition to the sebacinic acid a diaminopentane is used which can be obtained, for example, from a sugar-based material by a fermentation process.

Based on this biotechnical development, as opposed to the conventional methods of chemical conversion,

Fig 1 and 2: Air Filter Housing

(Photo: MANN + HUMMEL)



(Picture: Daimler)

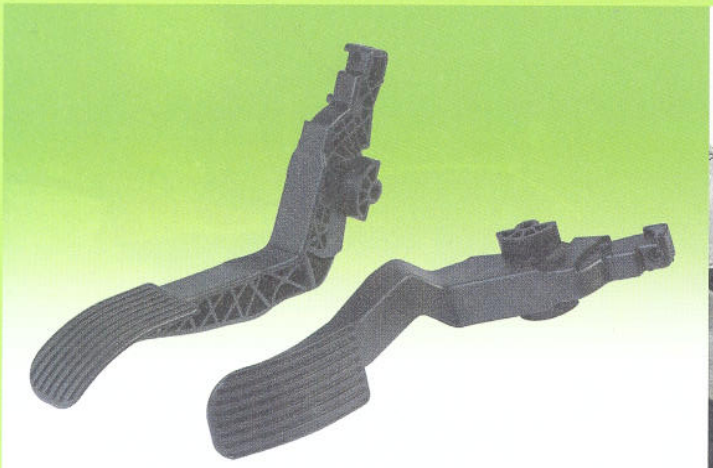
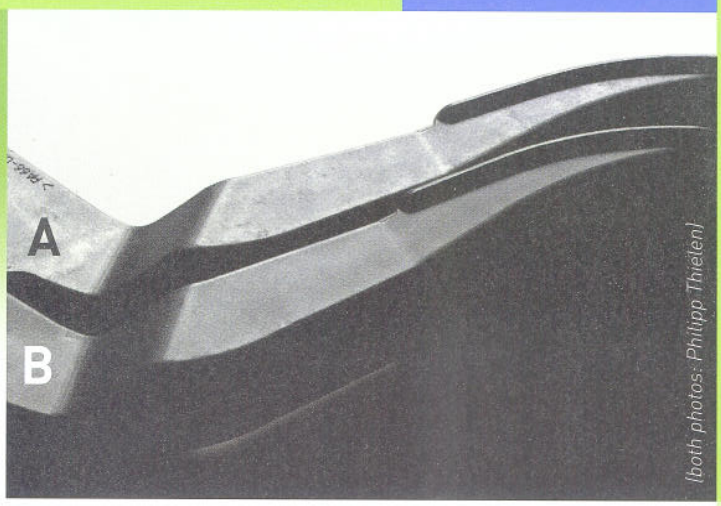


Fig 3 and 4: acceleration Pedal



The biobased PA 5.10 version (B) shows a much better visual surface quality

researchers at BASF have succeeded in developing an effective manufacturing process that ensures a high purity product. PA 5.10 is a polyamide based on 100% renewable resources and exhibits a particularly robust and technically relevant performance. However, as stated by BASF, currently the PA 5.10 is a rather expensive specialty PA. Thus a broad application in the cost sensitive automotive industry is not to be expected too soon.

The technical reasons for the selection and development of the PA 6.10 and PA 5.10 polyamide materials include their weight saving of about 6%, their low water absorption, their better dimensional stability and improved flow characteristics compared with conventional fossil-based PA 6 compounds. Where internal and external visible components made from bio-polyamide 5.10 are involved the material exhibits clearly superior visual (Fig. 4) and tactile properties that lend the parts a quality look. The first trial components (coloured trim parts for inside the vehicle) have proven very positive. Using the example of the air filter housing, the table below demonstrates the advantages of the PA 6.10 and PA 5.10 biopolymers.

In addition to the award-winning air filter housing made from PA 6.10 the group of collaborating companies has produced, analysed and tested other Mercedes parts made from PA 5.10 bio-polyamide. These include an accelerator pedal module, a cogwheel for the steering angle sensor, and a cooling fan and housing module.

The biopolymer components, given the medium and long term increases expected in oil prices, offer the potential for use at less volatile cost but with technical, and (because of the use of renewable resources) ecological advantages. Furthermore when using bio-polyamides, rather than the standard PA 6, the eco-balance is significantly helped in a positive way by the lower component weight.

In addition the market opportunities will be enhanced by an increased desire on the part of the consumer for resource saving products. In the future increased use will be made of innovative biobased materials. Daimler intends to use innovative materials in the production of vehicles with the aim of protecting the planet's finite fossil hydrocarbon resources.

As part of the joint project outlined above the PA 5.10 and PA 6.10 polyamides have been qualified and characterised. Sample components are being produced from bio-polyamides that are suitable for mass production processes and extensive functional trials are being carried out. In the case of Daimler for a product such as the air filter housing a series production is projected for 2010. MT

Material / Property	PA 6 (material from series application)	PA 6.10	PA 5.10
Biobased content (by weight)	0	63	100
Melting point [°C]	220	220	215
Glass transition temperature [°C]	54	46	50
Density [g/cm³]	1.14	1.07	1.07
Notched impact after 700 hrs ageing [kJ/m²]	22*	30**	-
Water absorption [%] (at 23°C / 50% RH)	3	1.4	1.8

*: PA 6 GF30, **: PA6.10 GF30 Ultramid Balance, BASF

Table: comparison of the properties of polyamides

www.basf.com
www.bio-pro.de
www.bosch.com
www.daimler.com
www.fischerwerke.de
www.mann-hummel.com
www.tu-braunschweig.de
www.vdi.de

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