Complex materials boost performance

Tom Shelley reports on partly bio-based materials that outperform conventional resins.

Considerable performance and cost benefits can be obtained by adopting composite constructions of novel materials, including some that derive from wood pulp, banana fibre and castor oil.

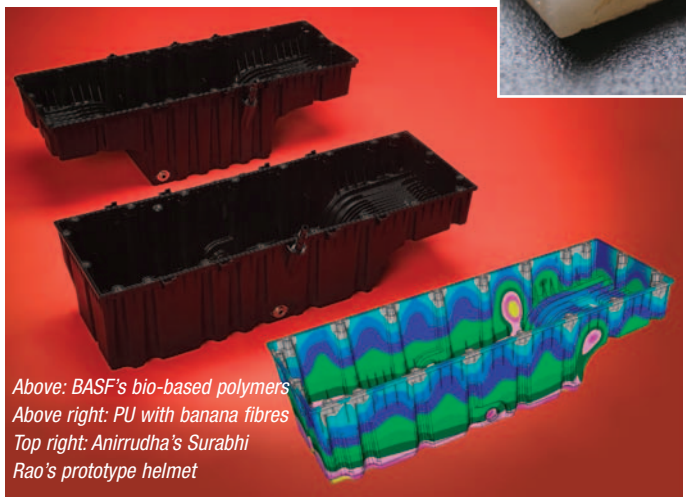
Any reduced environmental impact from their partly plant-based origins might be of interest, but it is their reduced weight and costs and enhanced performances that make them worthy of consideration.

For instance, structures made of corrugated cardboard treated with an acrylic waterproofing compound are being used in novel cycle helmets. They are lighter and more effective at absorbing impact than polystyrene foam and, if produced in volume, are likely to be much cheaper to manufacture.

Design graduate Anirudha Surabhi Rao showed some of his prototype helmets at this year's Royal College of Art summer show and claims that, as well as being protected by a patent application, he was already producing them to order for customers.

The cardboard is cut to form interlocking girders and treated with Acrylex 100, which has been developed by United Coatings to replace solvent-based enamels. Rao said that tests at Imperial College showed that the new helmets exceed the requirements of BS EN 1078 'Helmets for pedal cyclists and for users of skateboards and roller skates' by a factor of four. The fabrications are about 100g lighter than their polystyrene equivalents and equally recyclable.

The University of Las Palmas Gran Canaria, on the other hand, has found benefits in reinforcing vacuum cast polyurethane parts with fibre from local banana trees. Fibre can be extracted from almost all parts of the plants and has long been used to make fabrics in some parts of the world because of its high strength (540 MPa) and low elongation (3% to 5% at break). Adding banana fibre to polyurethane is said to both increase strength and reduce weight. The research at the University has been undertaken as part of the Spanish IBE-RM project framework, which focuses on rapid prototyping and rapid manufacturing.



Above: BASF's bio-based polymers
Above right: PU with banana fibres
Top right: Anirrudha's Surabhi Rao's prototype helmet

One company that has done a lot of work on bio-based polymers is BASF and the company states that 'Whenever possible and practical, BASF offers materials based on renewable resources'. However, it also recommends that a proper 'Eco-Efficiency Analysis be carried out before using bio-based materials as an alternative to plastics.

As an example, BASF cites the case of two hypothetical car intake manifolds with a designed service life of 200,000km. One design is made of a polyamide called Ultramid S Balance, 60% of whose base comes from sebacic acid, derived from Castor oil and conventional PA 6. The Ultramid S Balance series has lower density and reduced moisture uptake relative to PA 6 and PA66, but cost significantly more. Performing a full Eco Efficiency analysis then shows the higher costs outweigh the slight ecological benefit of the Ultramid S Balance, most of which derives from weight saving rather than the plant basis of the castor oil. A further problem is the volatility of the price of sebacic acid, which is typical of products derived from crops.

This does not mean that the S Balance series should not be of interest to engineers, however, since these materials offer great resistance to hot water and steam, as well as resisting environmental stress cracking when exposed to aggressive chemicals such as calcium chloride. The materials only exhibit a slight difference in mechanical properties between dry and conditioned states and are stronger, stiffer and have higher heat deflection temperatures than PA 12.

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