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Carbon fibre injection moulding hits the market

« Gerd Liebig discusses his priorities in his new role as head of sales at Sumitomo (SHI) Demag «

» Demand from automotive is pushing sales, says Thomas Oury at DuPont Performance Polymers »

The VW Passat extra-long fresh air grille has required Dr. Schneider to produce its lamellae in PA-CF30

Carbon fibre injection moulding hits the market

Carbon fibre has been seen as too expensive and in too short supply for mass application. But injection moulding compounds now benefit from waste fibre sources, as shown at the VDI Plastics in Automotive Engineering conference. By David Vink

An interior part on the Volkswagen Passat B8 car launched in July 2014 is a new milestone for injection moulding, according to Dr Thomas Meins, material technology manager at moulder Dr. Schneider Kunststoffwerke. The car's 160mm long grille slats (lamellae) on the 1,040mm extra-long and 97mm high fresh-air grille are "one of the first commercial applications of carbon fibre injection moulding in a high-volume series application not making use of classic carbon fibre reinforced plastic techniques, such as prepregs or textile structures", he said.

Meins was speaking about new interior designs and new materials opportunities at the March 2015 VDI Plastics in Automotive Engineering conference in Mannheim, Germany. He said fresh-air grilles increasingly provide interior design accents, round vents and short slats being followed by extra-long ones.

VW talked at the Passat launch of creating a feeling of lightness and generous space using lean dashboards with a consistent horizontal structure. The innovative air vent extends across the entire width of the interior and is the main dashboard design element.

The impressive length of the chrome fins integrated in the air vents "is like a band, designed as one continuous functional decorative element, interrupted only by instruments and the analogue clock", VW said. The company said the extra-long design has "a positive effect on climate control performance and ventilation acoustics".

An injection moulding solution was a challenge, calling for high strength and stiffness for maximum 2.5mm vertical lamella bending (at 60N) and overall grille unit 1.2mm horizontal deflection (at 86N), combined with long flow length in the 160mm long, 15mm wide and 3.5mm thin lamella parts. Although zinc or aluminium diecast metal (Z410 or AlSi9Cu3 alloys) would meet deflection requirements in such thin sections with extremely high flexural modulus levels of respectively 130GPa and 70GPa, they would exhibit "plastic bending at sudden increases in force", Meins said.

Akro-Plastic has cut clutch pedal weight to a minimum with various weight-saving measures, with short carbon fibre reinforced PA/PP blend playing an important role

High bending strength called for high glass fibre or carbon fibre reinforcement levels in a low viscosity polymer matrix, to prevent fibres showing through on the aesthetic moulded surface. But special aromatic polyamides (such as Grivory GVS6H from EMS-Chemie), or special PA MXD6 polyamides (such as IXEF 1022 from Solvay), could not achieve the required 160mm flow length below 4mm thickness. Ultra high-flow PA compounds would achieve no more than 70% of stiffness of the above-mentioned materials, but the required high-quality aesthetic surface would still remain unresolved.

Dr. Schneider found the solution with a newly developed, 30% CF reinforced PA6, injection-mouldable, high flexural modulus compound, with 40Gpa flexural modulus and "close-to-isotropic properties". Other plastics considered were much less stiff: PC/PET-MF15 with 4Gpa, PC/ABS-GF20 with 8Gpa and PA66/61-6T-GF60 with 20Gpa.

Meins showed a chart with maximum 230mm flow length achieved with PA6-CF30, compared with around 162mm for PA66/6T-GF60, 140mm for PA6-GF50 and slightly under 120mm for PA6-GF30 (the latter two presumably ultra high-flow grades).

Following success with the Passat lamellae, Dr. Schneider has examined

➡ Continued on page 14

➡ Continued from page 13

other applications, with for example 50% weight saving potential over magnesium or aluminium die-castings, and with up to 200°C operating temperatures. In the lamellae application, the PA6-30CF parts weigh 199g, while Z410 would have weighed 640g, AlSi9Cu3 445g. Other plastics considered would have been 468-580g.

The PA6-CF lamellae have other key features: they have a cool touch, anti-static properties (against dust pick-up) and conductivity which benefits metallic plating, when required.

Presently moulded in 50% glass fibre reinforced PPA, Ejot's Delta PT P plastic self-tapping screw has potential to save even more weight over aluminium substitution, following trials with 30% short carbon fibre reinforced PPA

BMW plans

In a paper entitled *"Sustainable with carbon"*, Dr Stephan Huber, who is responsible for technology projects concept development at BMW, referred to BMW's re-use of carbon fibre preform fabric off-cuts and production waste within the company's thermosetting resin based composite production.

He concluded, however, that for these dry (resin-free) surplus materials "development of thermoplastic [short] carbon fibre granulate represents the most efficient solution in terms of cost and benefits, as the high strength and stiffness properties offer high lightweighting potential in the injection moulding area".

This amounts to "around 10% weight saving over GF reinforced granulate and up to 20% if adjusting mechanical properties down to those of GF reinforced material", Huber added. The cost of such compounds is favourable, consisting mainly of polymer and processing costs, as the CF is an economically priced waste product, Huber suggested. "Serial production with the material is therefore the logical next and final step in terms of material development," he said.

BMW is working on injection moulding applications that use CF. Huber referred to pedal bearing blocks and water assist injection moulded (WIT) clutch pedals in PA6-CF – with respectively 10% and 17% weight-saving – as well as air intake noise reduction housings in PP-CF with 10% weight-saving. These "are foreseen to go into series production or switch over material [to CF compounds] in 2015", he said.

In a joint paper by Thilo Stier, sales and innovation manager at compounder Akro-Plastic, and Hans Schwager of Consulting 4 Carbon (who was, until mid-2013, BMW i-series project

manager), the emphasis was on CF reinforced thermoplastic compound clutch pedal development.

Stier discussed a 52% clutch pedal weight saving, with density reduced from 1.46 g/cm3 to 0.96 g/cm^3. This was achieved through combining Akromid Lite PP/PA-20GF (instead of PA66-GF40), i-CF ("intelligent" CF, from composite production waste/ off-cuts) and Mucell microcellular physical and chemical foaming, with 3.5% AF Complex PE 990310TM masterbatch from Akro-Plastic sister company AF-Color in a WIT process.

Clutch pedal work has been done in stages with injection moulding machinery producer Engel, Portuguese mouldmaker Moldetipo, fluid assist specialist company PME fluidtec and Spanish lightweight automotive systems specialist Batz S Coop.

In another application by Grammer, a centre console trial moulding weighs 1,460g, moulded in 10% i-CF reinforced PA66 (Akromid A3 ICF 10), compared with 1,680g in PA66-GF30, achieving the same stiffness at a lower reinforcement loading.

Trial substitution of 30% glass fibre reinforced PA66 with a 10% short carbon fibre PA66 in this Grammer centre console has saved 13% weight while retaining same stiffness

Ejot has tested 30% CF reinforced PPA (Akromid T1 ICF 30) in its Delta PT P self-tapping screws, which have been moulded in PPA-50GF from EMS-Chemie from 2010 and Akro-Plastic since 2014. Stier and Schwager said there is additional i-CF compound potential in cargo floors, conductive quick connectors, door handles, panels, paint-line supports, pedal bearing blocks and sunroof frames.

Recycled

Stier referred to an undefined "black box" stage to convert waste dry composite CF fabric into short CF for side feeding at up to 50% into a compounding extruder from Akro-Plastic's sister company Feddem. The extruder is encapsulated to prevent electrical/electronic equipment short circuits from CF dust.

Wipag started short carbon fibre reinforced injection mouldable granulate production in September 2014

Plastic recycling company Wipag displayed on its VDI conference stand an engine compartment housing which was trial moulded by Mann +Hummel in WIC PP 15, a 15% CF reinforced PP, with weight of 1,107g and flexural modulus 8,000MPa. This was shown alongside the same part in PP-GF30 with weight of 1,314g and flexural modulus 6,500MPa.

Wipag started WIC series short CF granulate compound production in September 2014. It takes in dry CF fibres from, for example, BMW car production and "secondary fibres from other sources". It chops and feeds them into an extruder, granulating underwater extruded strands, drying and applying "post treatment" to "close the loop" with finished CF reinforced injection moulding plastic granulate containing up to 40% CF. Aside from PP, other WIC series CF compounds use PA6, PA66 and PPA.

Launched at Fakuma 2014, BASF presented its first commercially available CF reinforced PBT compound on its VDI conference stand. This 15% reinforced Ultradur B4300 C3 LS grade is aimed at applications where CF conductivity provides anti-static properties, protecting sensitive electronic equipment, or avoiding dust pick-up and disturbance on, for example, conveyor systems or in paper handling. BASF says the new grade is laser-markable, can be welded and bonded to other PBT grades and is suitable for complex, thin-walled mouldings. Mechanical properties are similar to those for PBT-GF30.

Further developments from the VDI Plastics in Automotive Conference will be covered in the July/August issue of *Plastics News Europe*.