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High volume composites for the automotive challenge

FEATURE

Mark Holmes

Material manufacturers are increasingly finding new ways to combine the benefits of composites with the need for high volume production that the automotive market demands. Reinforced Plastics reports on these and some other new developments for the automotive sector.

A number of composite suppliers have developed new materials that are meeting the requirements of the automotive industry for lightweight yet structurally strong parts, but ones that can be produced commercially in high volume manufacturing situations. Dow Automotive Systems has developed VORAFUSE™ epoxy intermediates for prepreg applications, which combine epoxy resin with carbon fibers from DowAksa for improved handling and rapid cycle times for compression molding of composite parts for structural applications. The company says that it has been designed to meet growing demand in the automotive industry for lightweight materials that can be processed commercially.

VORAFUSE is designed to work in processes like compression molding to achieve fast cycle times. It can be cured in 2–5 min for high volume manufacturing and can be used to enable automated manufacturing solutions. Epoxy-fiber composites offer competitive strength and stiffness at much lower density, enabling the production of components that can function well with traditional metal parts in a hybrid construction. Potential applications for VORAFUSE are structural applications which require strength, stiffness and lightweight construction such as door inners, hood inners, A, B, C pillars, and roof rails (Fig. 1).

''OEM emissions and fuel efficiency requirements are expected to continue to increase, as is the implementation of lightweight materials,'' says Allan James, NAFTA Composites Market Manager, Dow Automotive Systems. ''VORAFUSE epoxy derivatives support mass production of high-strength parts. Like other Dow Automotive materials, it can be customized to match different manufacturing and performance requirements for a variety of applications.''

VORAFUSE is available in two grades and with a variety of fabric configurations. VORAFUSE P6300 grade is designed for high volume manufacturing with no tack for robot handling of 2D and 3D preforms and compression molding. VORAFUSE P6100 grade is formulated to accommodate diverse manufacturing scenarios from autoclave to out-of-autoclave processing on lower-cost tooling for medium to low volume applications. Fabric configurations for both grades comprise unidirectional tape as well as woven, braided or non-crimp fabric at a range of areal weights.

VORAFUSE P6300 prepreg technology is now available worldwide with no restrictions (Table 1). ''Our development started with the Ford Motor Company as our partner and we are very thankful for the collaboration that has resulted in the development of VORAFUSE P6300,'' adds Allan James. ''As automakers continue on the road of replacing metals with carbon fiber composites, we are able to offer our compression molding material VORAFUSE P6300 prepreg alongside our grades for RTM and wet compression, specifically our VORAFORCE™ epoxy resin systems, such as VORAFORCE 5300.'' (Fig. 2).

Dow Automotive Systems believes that significant increases in production rates will now be possible. ''In the area of prepreg technology, the production rates of the out-of-autoclave process vary from 7 to 20 min based on the chemistry and cycling of the temperature of the tool,'' explains Allan James. ''One of the greater challenges is the lay-up of the prepreg in the tool in an acceptable manner, which can increase the overall cycle time. The development of VORAFUSE prepreg focused on both faster chemistry as well as overcoming the lay-up challenges with automated preform production. The preforming process step can yield a part a minute while the chemistry is designed to cure in 2 min at 150 °C to achieve an overall maximum cycle time of 3 min. Allowing for robotic placement of the net shape preform and tool movement and robotic removal of the part, the cycle time is 3 min

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FIGURE 1
VORAFUSE can be used in compression molding of composites parts for structural applications.

FIGURE 2
Rear structure of an Aston Martin manufactured by Faurecia in VORAFORCE 5300 epoxy resin in a RTM process.

conservatively. This means that one set of tools can make 100,000–120,000 parts per year compared to 10,000–40,000 parts per year for the next best prepreg technology. The increase in production rate is three times faster than competitive technology.''

TABLE 1

Properties of VORAFUSE.

	VORAFUSE P6300	VORAFUSE P6100
Track	Track fee	Adjustable track
Autoclave capable	No	Yes
Compression mold	Yes	Yes
Cure time (min)	2–5	3–5
Compression mold		
Automation capable	Yes	Limited
Shelf life (weeks, pre-preg)	14	7

In addition, potential significant weight savings in vehicles manufactured using VORAFUSE technology could now be realized. ''The percentage weight saving is hard to gauge outside of doing development on specific components,'' James adds. ''Generally, one can achieve 60 percent weight saving with respect to steel and 40 percent for aluminum alloys with carbon fiber composites. As it is a compression molding process versus stamping, there is opportunity to reduce part count by designing for the process, which can give further weight savings as well parts consolidation, adding to the value of a carbon fiber composite. In the case of our development with Ford, we were able to save 6 kg per vehicle by replacing the B-pillar steel inserts with carbon fiber composites. Hence, there is significant opportunity to reduce weight in a vehicle by switching to carbon fiber components. It is key to determine which applications will most benefit from the strength of carbon fiber composites.'' (Fig. 3).

The VORAFUSE technology is also sufficiently flexible to allow customization to match different manufacturing and performance requirements. ''The base resin is the key innovation that has resulted in this tack free, room temperature shelf life, very fast curing and automation friendly system,'' James concludes. ''It is designed for simple compression molding so as to use existing capital rather than require significant capital expenditure. The resin can be combined with a variety of fibers and fiber orientations. In the development with Ford, we used carbon fiber produced by DowAksa in both braid, from A&P Technologies, and NCF (non-crimped fabric) from DowAksa to make prototype B-pillars. With the Ford GT made by Multimatic, we utilized 380 gsm weave carbon fiber from DowAksa to make a roof header and nose bottom part. We are testing glass fiber and hybrids of glass and carbon fiber and really see little restriction in using alternative fibers and fabrics. The different fibers and formats can be tailored for specific performance requirements as determined by our customers.''

High volume

In another new development, Solvay has launched thermoset prepreg resin system SolvaLite™ 730, which has also been specifically developed for high volume automotive applications. The material is formulated with Reichhold ADVALITE™ resins and is claimed to offer a combination of characteristics and benefits. These include: sub 60 s cure capability, making it ideal for high volume structural applications (150,000 vehicles per annum); standard properties in line with autoclave-cured high-performance automotive systems; good toughness when compared with other available rapid cure systems; low tack, designed for use in

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