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Supplier Reduces Weight of Sheet Molded Composite Plastic Parts by more than 25%

Continental Structural Plastics (CSP) of Troy, Michigan, reports significant new advances in weight reduction of thermoset parts used in automotive and non-automotive panels including exterior applications. A supplier of molded plastic components to the automotive OEMs and other industrial manufacturers, CSP actively pursues weight reduction and product improvement in accordance with CAFE (Corporate Average Fuel Economy) standards and the industry's quest for improved fuel economy.

According to Probir Guha, CSP General Manager of Materials and R&D, these advancements began with a goal of achieving substantial density reduction in sheet-molded compound (SMC) parts without affecting the manufacturing processes or compromising product quality.

"Recent technical advancements are based on incorporating new 3M high-strength glass bubbles in the SMC resin matrix," Guha explains. "SMC contains a resin matrix reinforced with glass fiber and contains calcium carbonate filler. Efforts to reduce density without compromising mechanical properties focus primarily on varying the calcium carbonate content and replacing it with lower density fillers. Filler alternatives include carbon fiber, organic fillers and nano particles. We find that 3M glass bubbles are generally superior in performance to other fillers due to their inherent strength and lower density, and the spherical form of this glass material improves resin flow and results in potentially higher filler loading."

3M™ Glass Bubbles are made from a chemically stable glass and have a high strength-to-weight ratio. Compared to alternate fillers, CSP finds that these bubbles reduce density, improve abrasion resistance, limit thermal expansion, increase surface hardness, improve dimensional stability, and help control material and process costs.

According to Guha, using 3M™ Glass Bubbles K37 as filler, CSP achieves a part density of 1.3 g/cc for non Class A structural parts, and this translates to a typical weight reduction of approximately 32% compared to unmodified SMC. These 3M glass bubbles have a nominal size of 40-microns, a crush strength rating of 3,000 psi and true density of 0.37 g/cc.

Class A Appearance Parts

Recent advances in high-strength glass bubble technology have made possible a new level of SMC part density reduction and weight savings in paintable SMC parts.

Mike Siwajek, the company's Manager of Materials Development, explains that glass bubbles used in the latest SMC material differ from the earlier 40 micron material most notably in their lower nominal size and higher crush strength values. Newer 3M™ Glass Bubbles iM30K have an isostatic crush strength of 30,000 psi – ten times that of K37 glass bubbles. Their nominal diameter is just 16 microns, and true density of the smaller bubbles is 0.60 g/cc (see Table 1).

"We find that the flow properties of 3M glass bubbles integrate well with SMC production, and actually enhance the process by improving resin flow," said Siwajek. "The flow advantage is particularly notable with regard to the shelf life of SMC raw material. Even after a period of months in inventory, resin formulated with the new smaller bubbles continues to flow well and fill out molds dependably. We can achieve a weight reduction of approximately 25 percent for a given part with 3M iM30K glass bubbles compared to calcium carbonate."

Table 1. 3M™ Glass Bubbles K37 and iM30K Properties

3M™ Glass Bubble	Crush Strength	True Density	Approximate SMC Weight Reduction for CSP
K37	3,000 psi	0.37g/cc	32%
iM30K	30,000 psi	0.6g/cc	25%

According to Siwajek, steps taken early on to lower SMC part density in existing tooling with nano clays and other formula refinements replacing calcium carbonate sometimes led to dimensional problems related to part shrinkage in the tool. This problem has been alleviated through the use of glass bubble filler material, and today CSP demonstrates the ability to achieve the required dimensional control and meet even the very high tolerance standards of parts such as automobile hoods.

Surface Finish

CSP reports that one important challenge in SMC panel production with glass bubble filler is paint-ability. While it is possible to achieve a density of 1.3 g/cc, and good physical properties for SMC panels using 3M™ Glass Bubbles K37, components made in this manner will not meet the OEM's Class A surface standards. The 40-micron bubbles at or near the surface of an SMC part tend to pull out of the panel or fracture during finish sanding, leaving voids and unacceptable paint surface defects.

However, with the new smaller 16-micron 3M™ Glass Bubbles iM30K from 3M, and proper surface preparation, reduced density can be reached along with good surface quality. "CSP is able to meet OEM Class A standards in low density painted appearance panels with the smaller size and increased crush strength of iM30K glass bubbles," Siwajek said. "3M directed abrasive and surface and texture analysis technology resources to this challenge, and they've provided information related to materials and methods that allow us to meet OEM finish standards for SMC appearance panels made with the 16-micron glass bubble filler."

SMC Component Example

Mike Siwajek explains that a notable product enhancement demonstration accomplished with the new low density SMC filler material is a weight reduction of 11.5 lbs for the hood of a large U.S. SUV. Using standard construction, the weight of this 48" x 65" hood assembly is 40.5 lbs, including an outer panel weight of 21.5 lbs and an inner panel weight of 19 lbs.

The lightweight version of the hood consists of a 1.5 g/cc density outer panel with iM30K bubble that weighs 16 lbs (a 5.5 lb savings), and an unfinished inner panel made with larger K37 bubbles at 1.3 g/cc density that weighs 13 lbs (for an additional 6 lbs in weight reduction). Thus with glass bubble composition, the combined hood weight is reduced from 40.5 lbs to just 29 lbs for a weight savings of 28%. Siwajek notes that this reduction is accomplished with acceptable structural properties since strength tests show that the lower density parts constructed with 16 micron 3M glass bubbles fall within the standard deviation of prospective new OEM dimensional and safety specifications.

"This SMC process development intersects favorably with energy-driven market changes that call for lighter weight and improved production efficiencies," Probir Guha concluded. "Our experience to date confirms that density reductions can be accomplished with glass bubbles using current manufacturing processes with good produceability, and only minor differences in strength compared to unmodified material. CSP continues to work with automotive OEMs to explore weight savings opportunities for SMC appearance parts, as well as addressing other vehicle applications such as heavy trucks, agricultural equipment and defense."

Continental Structural Plastics (CSP) is North America's largest producer of sheet molding compound (SMC) and glass-mat thermoplastic (GMT) composite parts for the automotive, heavy truck and other industries. CSP operates multiple plants (Carey, Ohio; Conneaut, Ohio; Van Wert, Ohio; Sarepta, Louisiana; and Tijuana, Mexico) producing raw SMC and utilizing compression molding to produce fiberglass-reinforced hoods, fenders, pickup boxes, underbody shields, oil pans and other components for General Motors, Chrysler, Ford, Toyota, International Truck, and John Deere, among other customers.

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