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The Thermoset Resin Industry – A New Business Model?

by

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Abstract

The thermoset resin industry, specifically SMC and BMC, market share in the automotive industry is estimated at 325 million pounds (147.4 million kilograms) in North America. If these materials were used to their full potential, the amount used should be twelve times the current market size. The supply chain was surveyed to determine how to more effectively meet the needs of the industry to fully capture this market share. The research included investigating the current materials and processes along with the potential for new materials and processes. The results indicate that there are opportunities for SMC and BMC to increase their market share over metals in the automotive industry. Future changes within the automotive industry present an increased opportunity for these thermosets. To achieve this increased market share, it is suggested that the industry adopt a collaborative style of technical development and marketing. A collaborative effort within the thermoset industry will keep the industry competitive with competing materials and will grow the business with thermosets' advantages. The formation of a collaboration of industry (raw material suppliers, tool shops, molders, and OEM's), universities, and government will be reviewed for further discussion and action. This paper will explore ways to achieve that collaboration.

SMC/BMC Market

Within the transportation segment, SMC/BMC comprises the second largest composite manufacturing process with about 750 million pounds (340.1 million kilograms) shipping globally in 2004. In the U.S. in 2007, the transportation market was estimated to consume about 325 million pounds (147.4 million kilograms) of SMC/BMC materials. Ford Motor Co. uses more SMC annually than any other North American OEM, estimated at 150-200 million pounds (68.0-90.7 million kilograms) annually. Yet despite continued demand for products, the North American SMC/BMC market can become flat due to challenges associated with developing new ideas and competition from other processes. (1)

Lightweighing in the Automotive Industry

To significantly reduce oil consumption, especially dependency on foreign sourced petroleum, the car manufacturers in America, principally Chrysler, Ford and GM, have been mandated by the Federal Government through President Bush's 2002 FreedomCar Initiative to reduce average passenger car weight by 50% by the year 2020. This initiative is currently overseen by the Department of Energy's Energy Efficiency and Renewable Energy (EERE) Office for FreedomCar and Vehicle Technologies (FCVT) and Automotive Lightweighting Materials (ALM).

Specifically, the 2020 FreedomCAR goals for high volume production of automotive vehicles would, while maintaining same vehicle size, comfort, and safety standards compared with 2002 vehicles, have the following characteristics:

- Half the mass
- Are as affordable
- Have the same performance
- Are more recyclable (75% today, but with the European aim of 95%)
- Are of equal or better quality and durability. (2)

Although, according to the President's program, the new weight reducing FCVT technologies must be available for 2020 full scale automobile production, these new technologies actually need to be incorporated into the engineering designs for demonstration cars and light trucks by 2015. The automotive companies take this federal mandate very seriously and are quite concerned about reaching the established FreedomCar weight reduction targets. Accordingly, they have already implemented many weight saving or Automotive Lightweighting (ALM) technologies such as the replacement of heavy steel structural components with more usage of lighter weight / stronger aluminum alloys, more exotic magnesium and titanium alloys and higher strength, but thinner gage steel materials. They have also transitioned to thinner, lighter weight glass for all car windows. In addition, they are already designing new vehicles with increasing amounts of plastics and lighter weight composite materials. What has become patently obvious to the automotive industry, is that weight reduction for all such vehicles, no matter what fuel or power system employed, will also lead to reductions in both energy consumption and harmful emissions. (3)

Renewed Interest in SMC/BMC Materials

A number of recent articles have espoused the merits of SMC and BMC. One of the problems of SMC formulations have been paint pops, high temperature resistance for E-coat application, and reduced cycle times for reduced cost. A Reinforced Plastics article points out that a consortium initiated by Dr. Hamid Kia was formed to reduce the effects of moisture and air that outgas from traditional SMC during the paint bake which creates paint pops or defects in parts being primed. Results obtained were improvements of the Class A paint finish of SMC exterior cladding during powder priming on the OEM assembly line. (4)

Another article identifies sheet molding compound as showing a growing promise in a variety of other temperature and weather resistant applications. These applications range from enclosures for electrical utilities both above and below the ground. Lower weight SMC materials have reappeared in marine engine cowls. (5)

OEM profit margins have suffered, and as a result, interest has been triggered in looking at replacement materials as well as alternative processes that could reduce costs. Rising costs of plastic resulted in companies pushing steel fuel tanks launching a big market and technology drive several years ago through the Strategic Alliance for Steel Fuel Tanks. (6)

Articles point out these four materials are under significant price pressure: palladium, aluminum, steel and plastics. Design News points out 10 strategies that the magazine has developed that can be used to reduce exposure to high and unpredictable, materials prices. One strategy is to substitute sheet molding compound (SMC) for flat rolled steel. The positive is that these composites are usually 25 to 35 percent lighter than steel parts and can be fabricated with low-cost tooling, and the negative is the process can be slow and the recycling track record is far inferior to steel. (7)

A study given as a presentation at the Society of Automotive Engineers compared the life cycle cost analysis of steel, aluminum, and composites in automotive structures , a fender. (8) Another study was done on a decklid comparing SMC, aluminum, and steel. (9) SMC has been shown to have an advantage when life cycle costing is taken into consideration.

Other innovations that have been discussed are paint-free SMC's, Eco-friendly SMC's, improved quality control tests, and new manufacturing processes being investigated in Europe. (10)

Needs of the SMC/BMC Industry

The competitive environment requires that innovation continues in the SMC/BMC industry to drive down costs, improve quality, and decrease weight. In addition the industry needs an easy way for those not experienced in composites to design with composites. (11)

To address these needs, research is proposed for new, lighter weight, higher strength and more environmentally friendly sheet molding compound / bulk molding compound (SMC/BMC) materials, as well as, the development of lower cost and better controlled manufacturing methods, and more friendly avenues to design with SMC/BMC composites. A friendlier avenue to design with SMC/BMC composites would facilitate the rapid commercialization of such new composite materials via a fully integrated database repository and a virtual design and rapid prototyping operation.

How Does One Innovate in Today's Business Environment?

The rapid business model change for the OEM's consist of the consolidation of platforms, vehicle architectures, and global components. The impact of these decisions by OEMs will be monumental. Suppliers that are prepared for change and have globally positioned themselves from an engineering and manufacturing footprint will survive. OEMs will look to suppliers to manage more in all the major regions of the world. Those suppliers that have not embraced change and are still living in denial will be consolidated either through mergers and acquisitions, purchased by private equity, or quite simply will just go away. The pressure will be on and the squeeze will eliminate several hundred suppliers over the coming years. (12)

If the economics of companies that injection mold thermoplastics are similar to companies that compression mold or injection mold thermosets, then the number of companies in a position to innovate with major innovations are limited . (13)

So what is the solution? The fact remains that suppliers that collaborate with others including OEMs and other suppliers will have the upper hand. Major OEMs like Toyota have encouraged this behavior and have, in fact, awarded business on certain commodities to suppliers that have banded together to design and engineer common components. (14)

Opportunities for Collaboration

Examples of organizations that provide opportunities for collaboration include the American Composites Manufacturing Association, European Alliance for SMC, Composite Innovation Centre, Automotive Composites Alliance, and the National Composite Center (NCC).

In addition, local, state, and federal governments provide incentives for collaboration. Examples in the following paragraphs indicate how these funds can leverage funding from companies and universities with government funds. These funding mechanisms also facilitate collaboration.

The SMC/BMC industry has a geographic concentration of interconnected companies and institutions around the State of Ohio. These clusters of independent and informally linked companies and institutions represent a robust organizational form that offers advantages in efficiency, effectiveness, and flexibility. (15)

The State of Ohio through the Third Frontier Project awarded $1.8 million dollars (capital funds, minimal operating funds) in a Wright Capital Grant to NCC in 2006 was for the scale-up of an SMC line which would work with nano materials for reducing the mass of sheet molding compound. (16) This project in collaboration with industrial partners was designed to demonstrate at scale the use of nano modifications to a standard SMC. Molders throughout Ohio produce SMC for automotive, heavy duty truck, agricultural and recreational products. Their business could be increased substantially if they could produce consistently an SMC material which has a 33% reduction in specific gravity. A 2 million pounds (0.91 million kilograms) per year SMC line was installed at the Dayton Campus for Advanced Materials Technologies (DC-AMT). This site was selected in cooperation with the City of Dayton, Ohio to help re-establish Dayton's West side as a new location for advanced materials manufacturing. A new molding process developed in Australia called Quickstep was also selected for its potential to mold modified SMC. The Quickstep process has been installed and running and is drawing the attention of the aerospace industry as an alternative to autoclave curing of high quality aerospace parts. With the SMC line, this site will be able to produce and mold modified SMC in a pre-preg form not previously done before.

A recent Research Commercialization Program (RCP) grant proposal through the Third Frontier Project was submitted in January 2008 for $5.0 million for a total $10.0 with $5.0 million in matching funds. This proposal was to work with a broader molder base in Ohio to develop and certify both nano and bio based modified composite materials. This proposed research addressed the need for new, lighter weight, higher strength and more environmentally friendly SMC/BMC materials for the automotive and ground transportation industry, as well as the need for lower cost, better-controlled manufacturing methods. Included in the proposal was an integrated knowledge center utilizing virtual, state-of-the-art rapid prototyping. The project would integrate and apply this suite of newly developed breakthrough technologies to structural parts and body panels for automotive vehicles, trucks, and other transportation modes in close collaboration with government, industry and university partners.

Collaborative commercialization efforts would be facilitated by bringing together the intellectual capital of participating universities through other Third Frontier programs involving biobased materials technology (OBIC), nano technology development (CMPND) and information technology (daytaOhio); the raw materials capabilities of Ohio chemical and nanomaterials producers; Third Frontier-enabled facilities, technical support, and testing at the SMC line provided by the Third Frontier Grant. Parts molding and feedback would be provided by Ohio SMC/BMC molders and down-steam OEMS in the automotive and ground transportation industries Finally, workforce training would be carried out as an integral part of the various stages of the project using students and faculty from nearby community colleges.

The ultimate outcomes of this proposal was to (a) significantly grow the overall share of these materials in the industry, and (b) position Ohio to be the industry leader in lightweight SMC/BMC composites, particularly for automotive and ground transportation applications. The proposed SMC/BMC composites would match or exceed the existing cost-performance curve for steel and aluminum, especially for lower-volume applications (<100,000 units due to mold savings), at a reduced weight to address growing environmental concerns. In this way, traditional automotive materials can be replaced to a greater extent with lighter, stronger and more durable ones.

This proposal was not granted by the State of Ohio when compared to other proposals. Feedback from this grant proposal would indicate that the following areas must be addressed:

- Demonstration that bio-fillers and bio-reinforcements will permit significant substitution for current materials, particularly at an affordable cost.
- The issues of styrene emissions, recycling,

and surface quality including paint defects in the development of these materials.

- Determine whether the fragmented nature of the SMC industry and its orientation toward proprietary formulations will result in centrally-developed technologies to be readily implemented.
- Lastly, and more importantly, determine if there is commitment from the auto industry – a major "customer" with stringent requirements to support these programs in order for SMC to have a positive impact on the viability of the industry. Can the commercial goals be met?

Another funding source is the federal government. For example, grants are given to small businesses through the Small Business Technology Transfer Phase I projects (STTR Phase I) through the National Science Foundation. These grants can be another source of collaboration with small entrepreneurial companies. (17)

The Conclusion

While collaboration in the SMC/BMC industry has been practiced with some degree of success, the comments from the proposal evaluators indicates that the industry must pull together to make SMC/BMC a viable material and process.

Examples of potential collaborations illustrate that there are organizations and facilities capable of managing these collaborations.

So is collaboration important? No. It is absolutely critical. And the ones that embrace this mindset and stop paying it lip service will survive and likely thrive long-term in this highly competitive global automotive industry. (18)

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