Composites® International
THERMOSET MOLDING COMPOUNDS

Manufacturers Turning to Thermoset Molding Compounds to Replace More Expensive, Less Versatile Metals

If you were asked to define the term "precious metals," you would most likely list gold, silver, platinum and possibly even a few of the more exotic metals such as rhodium and palladium. In recent years, however, many design engineers and manufacturing managers would argue that such metals as copper, steel, aluminum, zinc, tin and a few other "common" metals should be added to the list. Consider these recent headlines:

Copper's Record Run Nears $10,000 Per Ton – *Bloomberg News, 2/1/11*

Tin Races to All-Time High – *Bloomberg News, 2/1/11*

Steel Prices Set for 1-2 Years of Rises – *Metal Miner, 12/22/10*

UBS Raises Forecast for Metal Prices for 2011 – *The Canada Press, 12/14/10*

This is not a recent phenomenon, as seen in this headline of a year ago:

Metal Prices Rise Strongly Again – *BBC News, 2/15/10*

Interestingly, in that year-old article, the writer cited a prediction by the Societe Generale's Director of Metals that copper, whose price was at $6,567 per ton at the time of the article, would "rise to an average of $7,435 per ton for the year as a whole."

Exactly one year later, on 2/15/11, copper reached $10,190 per ton. And, it's not just copper. As evidenced by the headlines above, aluminum, steel, tin, zinc and other metals are at or near all-time highs.

Another factor to consider is the volatility of metal prices. Consider the recent history of aluminum, currently trading at approximately $2500 per ton. In July of 2008, aluminum stood at $3,070 per ton. Barely 8 months later, in March of 2009, it had dropped to $1,340 per ton. Good news, right? Not really, as its price (like those of most commodities) was driven down by the most severe recession since the 1930's. The bounce back in aluminum prices, fueled by a recovery that can hardly be described as robust, has essentially doubled the price in less than 2 years, and Forbes predicts that it will hit as much as $3,400 within the next two years. Writing in Forex Journal in February of 2009, Scott Wright notes "Copper, zinc, nickel lead, and aluminum achieved **staggering trough-to-peak gains of 574%, 523%, 1,124%, 829%, and 151%.**"

What's a poor design engineer or product planner to do?

An Attractive Alternative

One potential answer to the question is to consider converting from metal to thermoset composites such as those formulated and manufactured by IDI Composites International of Noblesville, Indiana. Also known as fiberglass-reinforced polyester molding compounds, they are available as both Sheet Molding Compounds (SMCs) and Bulk Molding Compounds (BMCs). As we will discuss in this article, manufacturers of products in a wide variety of industries are increasingly converting metal-based designs to IDI's thermoset composites.

First, though, let's answer the obvious question: Aren't thermoset molding compounds, because some of their content is based on petrochemicals, just as volatile – price-wise – as metals?

In a word, no. While thermoset molding compounds are partially comprised of hydrocarbon-based polymer resins (such as polyesters, vinylesters, and epoxies), they contain several other ingredients, most notably the glass fibers that give composites many of their most desirable physical properties. As demonstrated in the following graphs (Figures 1-3) that compare the pricing history of aluminum, zinc, and steel to BMC and SMC over the past several years, metals exhibit substantially more volatile pricing patterns:

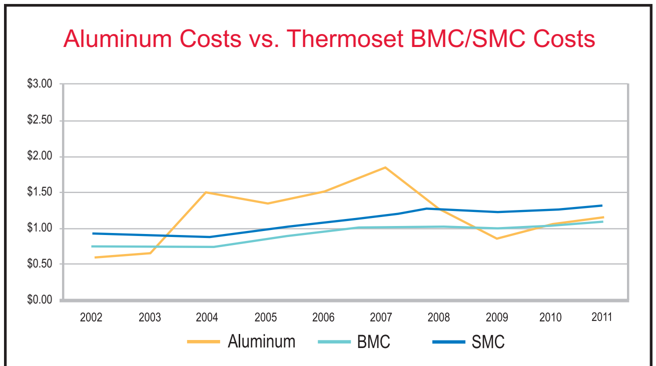
Beyond Price Volatility

So, the price of thermoset composites is much less volatile than those of most – if not all – metals. Is that the only reason why manufacturers are converting their product designs from metal to BMC and SMC? Not by a long shot. In fact, the reasons for metal-to-composite conversion include:

- Significant part reduction
- Lighter weight
- Better corrosion resistance
- UV resistance
- High impact strength
- Superior electrical insulation
- Molded-in color
- Reduced tooling cost

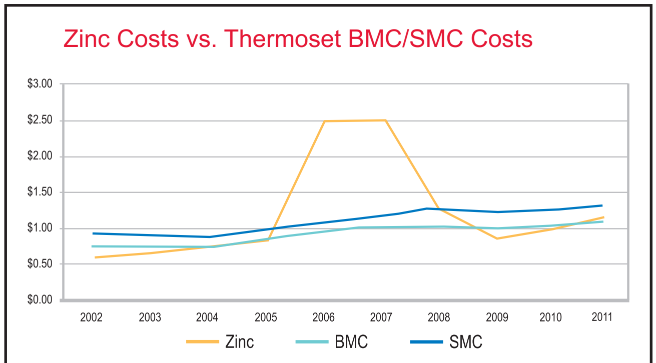
Manufacturers of products in a wide variety of industries are increasingly converting metal-based designs to IDI's thermoset composites.

Figure 1:



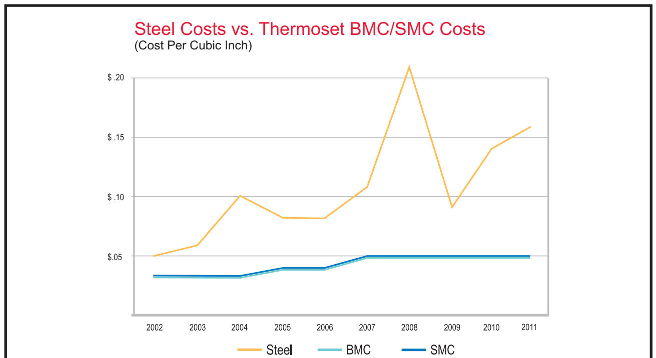
Comparison of relative prices of aluminum, BMC, and SMC.

Figure 2:



Comparison of relative prices of zinc, BMC, and SMC.

Figure 3:



Comparison of relative prices of steel, BMC, and SMC.

In fact, thermoset composites compare very favorably with metals such as aluminum, zinc, and steel in properties such as density, corrosion resistance, and flexural/tensile strength and modulus.

Thermoset composites provide not only an attractive alternative to many metals, but can also fill the gap between thermoplastics and metals, as demonstrated by figure 5.

Let's look at some recent conversion case histories to illustrate just a few of the reasons for conversion listed above.

Parts Consolidation

The Berkel Company, a leading manufacturer of high quality slicers and mixers for the North American food service industry, was looking to enhance their new line of food slicers. The existing line of slicers was made almost entirely of aluminum, and research had shown that the current slicer took upwards of 90 minutes to clean. Additionally, as many as eleven possible harborage points for bacteria were found in the seams where the aluminum base and food plate "drip and drop zone" assemblies were bolted and welded together. Berkel was seeking a material that would eliminate these bacteria harborage points and enable more efficient cleaning of the tool.

Converting to IDI's thermoset bulk molding compound answered the design challenge. IDI was able to provide Berkel with an aesthetically pleasing BMC, custom-formulated for the slicer. And, because the entire base was transformed to a single molded part, troublesome seams found in the previous aluminum design were completely eliminated.

Utility Associates, a major manufacturer of mobile operations information communication systems, converted its OnComm Rocket™ advanced onboard mobile communications hub from a metal-based design to IDI's bulk molding compound. Prior to the conversion, the unit's electronic components and firmware were housed in a tamper-proof lockbox that included 30 different parts, some of which were laser-cut, formed, welded, plated, and then assembled to make one part. Several suppliers were involved. Lead times were excessive.

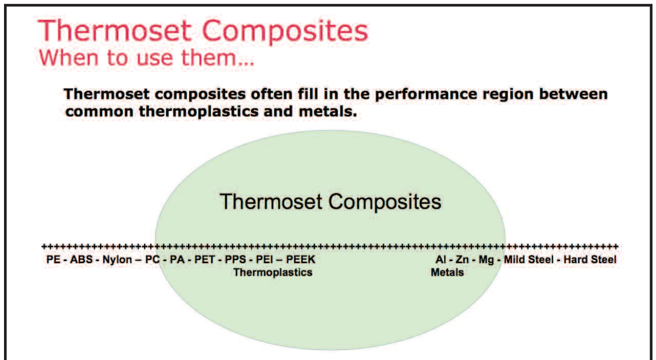
Figure 4:

Metal Replacement: Thermoset vs. Metals

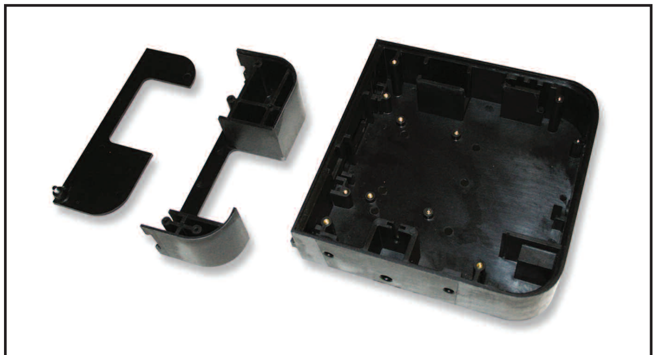
	BMC (25% glass)	SMC (50% glass)	300-Series Aluminum	Zinc	Steel
Density	.07 lbs/in³	.07 lbs/in³	.09 lbs/in³	.24 lbs/in³	.29 lbs/in³
Linear Thermal Expansion Coefficient	8-12 in. x 10^{-6} /K @ 20°C	8-12 in. x 10^{-6} /K @ 20°C	12-13 in. x 10^{-6} /K @ 20°C	15-16 in. x 10^{-6} /K @ 20°C	9-10 in. x 10^{-6} /K @ 20°C
Corrosion Resistance	Excellent	Excellent	Good	Fair	Fair
Flexural Strength	10-20 psi x 10^3	20-30 psi x 10^3	10-25 psi x 10^3	N/A	30-35 psi x 10^3
Flexural Modulus	15-20 psi x 10^3	15-20 psi x 10^3	100 psi x 10^3	N/A	280 psi x 10^3
Tensile Strength	5-10 psi x 10^3	10-20 psi x 10^3	10-25 psi x 10^3	10-25 psi x 10^3	30-35 psi x 10^3
Tensile Modulus	10-25 psi x 10^5	10-25 psi x 10^5	100 psi x 10^5	N/A	280 psi x 10^5

BMC and SMC compare favorably to metals in several physical properties.

Figure 5:



Thermoset composites often fill in the performance region between common thermoplastics and metals.



These BMC thermoset composite parts replaced 30 metal parts that required extensive secondary processing.

Utility needed a solution that not only reduced product complexity, but also that would be considered a quality and aesthetic upgrade, was equally as strong as steel, and was more reproducible. The Rocket™ was redesigned using IDI's BMC 44-10, one of many IDI molding compounds that combine excellent strength and surface appearance with corrosion and flame resistance, while reducing weight (up to 35% lighter than steel parts of equal strength). Unlike metal enclosures, thermoset molded components will not become dented over time by random impacts, thanks to the excellent memory characteristics of BMC and SMC.

Part count was reduced from thirty to five. Several manufacturing processes were eliminated. The supply chain was reduced from several suppliers to just two. Cost, although it was not a reason for investigating alternative materials, was also reduced. Equally important, however, through the use of the composite material, Utility was able to more effectively handle demand surges by maintaining a much higher inventory of "kitted" parts.

Corrosion Resistance and Weight Reduction

a major manufacturer of mobile operations information communication systems, converted its OnComm Rocket™ advanced onboard mobile communications hub from a metal-based design to IDI's bulk molding compound. Prior to the conversion, the unit's electronic components and firmware were housed in a tamper-proof lockbox that included 30 different parts, some of which were laser-cut, formed, welded, plated, and then assembled to make one part. Several suppliers were involved. Lead times were excessive.

According to Design News and the Automotive Composites Alliance, the Dodge Viper uses 15 SMC parts, more than any other car. (Design News, 11/16/10. Photo courtesy of Chrysler Corp.)

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Currently, IDI is supplying materials that include its SMC AV-206, which is used in applications such as valve covers, where it replaces heavier, more expensive die-cast aluminum covers. In addition to its high physical and mechanical strengths, other features that make it ideal for automotive and heavy truck applications include:

- Corrosion resistance
- Light weight
- Heat resistance (high thermal stability)
- Electrical non-conductivity
- High NVH (Noise Vibration Hardness) rating
- High impact resistance

Thermoset composites also dramatically reduce secondary operations (such as machining and drilling) typical of die-cast aluminum and other metal parts.

IDI's SMC thermoset composites replaced die-cast aluminum in this valve cover.

In addition to valve covers, IDI's thermoset composites find application in:

- Exterior body panels
- Headlamp & tail light housings
- Oil drain pans
- Timing chain covers
- Injection pumps
- Intake manifolds
- Windshield wiper housings
- Under-the-hood electrical & heat-shielding components
- Battery casings & covers
- Bumpers, bumper beams & grill assemblies
- Air deflectors & spoilers

BMC and SMC are also used for a variety of automotive interior structural and cosmetic components. They are capable of producing a surface rivaling that of steel, including Class surfaces.

Additional Applications for Metal-to-Composite Conversion

IDI Composites, the foremost manufacturer of SMC and BMC materials, is also the global leader in helping companies improve product design, manufacturability, and performance by switching to thermoset molding compounds. IDI has successfully converted many cast aluminum, zinc, iron, steel, and other custom fabricated metal parts to thermoset composite materials, providing its customers with substantial cost savings and superior performance. Other examples of metals conversion with thermoset molding compounds include wastewater station components (such as lids and flanges), construction door skins, and detectable warning plates installed in ADA curb ramps.

IDI has successfully converted many cast aluminum, zinc, iron, steel fabrication, and other custom metal fabrication parts to thermoset composite materials.

To learn more about metal-to-composite conversion, go to our web site, www.idicomposites.com, and select any of the excellent case histories or application sheets on our Library page.

Getting Started

Design engineers who are considering converting their metal-based product designs to thermoset composites might ask “How do I get started in evaluating whether a conversion makes sense for me?” IDI has made this simple by establishing a Metals Conversion Project Support Team at its headquarters in Noblesville, Indiana. Comprised of Paul Rhodes, Vice President of Marketing, and Gary Littell, Application Development Engineer, the Metals Conversion Team can quickly help you evaluate your application. They can be reached at 317-773-1766.

About IDI Composites International

IDI Composites International is the premier global formulator and manufacturer of thermoset molding compounds for custom molders and OEMs. The company provides customized polyester/vinylester-based bulk molding compounds (BMCs) and sheet molding compounds (SMCs) for the world’s most demanding markets, including automotive, electrical, transportation, telecommunications and military/aerospace.

Headquartered in a 200,000 square foot facility in Noblesville, IN (USA), IDI has a strong presence in the international thermoset composites market. To support a growing customer base world-wide, the company operates multiple wholly-owned manufacturing facilities in Europe, Asia, and The Americas.

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