Meeting the **Magnesium Challenge**

Lightweight alloys make automotive LED lamp assemblies lighter and more cost effective. **DENISE KAPEL, SENIOR EDITOR**

As fuel costs rise and efficiency standards tighten, lightweight alloys such as magnesium present new opportunities for metalcasters serving the automotive and transportation industries. The Obama administration recently finalized standards requiring increased fuel economy equivalent to 54.5 mpg for cars and light-duty trucks by model year 2025. The program includes incentives for automakers employing advanced technologies to improve vehicle characteristics such as weight.

Michael Pickholz, CEO of technology development company MagWerks LED, Oxford, Mich., recently went looking for a metalcaster that could prototype lightweight, reliable LED (light-emitting diode) lamps for automotive customer Sealink International, Largo, Fla. Jack Ziemba, owner and CEO of Aristo-Cast Inc., an Almont, Mich., investment casting facility, had just the solution for him.

Ziemba had developed a proprietary process for magnesium investment casting in-house, which overcame the metal mold reaction that occurs with magnesium and the silica shell material and reliably achieved cast wall sections as thin as 0.02 inch (0.5 mm). Initially, Pickholz worked with Aristo-Cast on a 7-inch (17.8-cm) round, AZ91E magnesium alloy LED headlamp he had invented. Following the success of that project, the companies collaborated on a prototype for a fog lamp.

The Process

"We tell [our customers], 'Put everything you want into your casting, and we'll tell you what we can and can't do,'" said Paul Leonard, vice president, Aristo-Cast. "In this case, there were some very minor modifications that had to be made, such as some radii added."

"If we're allowed to deviate from the design by adding a radius, it improves the whole operation and adds to the strength of the part," Ziemba said. "On the exterior, if you have a sharp edge, it becomes a weak spot when you're building the shell."

Oxygen in the shell also presented a challenge. "Magnesium in a molten state is hungry for oxygen," Ziemba said. "It will grab hold wherever it can, and that's one of the things you want to keep from happening. The fused silica shell is SiO_2 so we had to come up with a method that would isolate the magnesium and stop it from grabbing the oxygen out of the shell, which would be detrimental to the surface finish."

Aristo-Cast exposes the shell material to a proprietary treatment at the end of the process. "Everything up to that point is conventional gravity-pour investment

MagWerks offered its automotive customer an energy-efficient LED direct replacement lamp (above) weighing less than half that of any other available LED lamp of this type, according to the company. Additional lighting systems are under development.

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—Jack Ziemba, owner and CEO, Aristo-Cast Inc.

casting shell build," Ziemba explained. Aristo-Cast's process also prevents the magnesium from igniting due to the presence of oxygen.

Magnesium's Advantage

While traditional incandescent automotive lamps are housed in injection-molded plastic, high-powered LED lamps require a metal heat sink, as they will degrade and fail if they are allowed to exceed their rated temperature. The heat is dissipated through components designed into the cast part itself, generally produced as A380 aluminum alloy extrusions or die castings.

As automotive manufacturers and the transportation industry address rising fuel costs, lightweight parts are becoming increasingly critical.

"When you're talking about only two-thirds the weight, it doesn't sound like a whole lot, but when you put that in your hand and you feel that, [magnesium] offers a weight savings like no other," Leonard said.

Pickholz noted the advantage of the thin walls that can be achieved with magnesium. "You're making [the part] with a low material content which, in addition to magnesium's weight versus aluminum, makes the product extremely lightweight and very cost effective. You're essentially ticking all the right boxes in the process while accomplishing what you need to do, which is to remove the heat from the lamp, from the LED proper."

The shell system Aristo-Cast uses produces a shell that is seldom over 0.1875 in. (4.76 mm) thick, versus the more conventional investment casting shell thickness of 0.375 in. (9.525 mm).

"It enhances our ability to fill very thin sections, and it cuts material costs," Ziemba said.

Beyond weight savings, investment casting enables part design without draft. "It allows the LED products to be as lightweight as possible, but it also allows the rendering of a sufficiently smooth finish capable of yielding a class 'A' reflective inside light surface," Leonard said.

Aristo-Cast's magnesium investment

casting process has opened up a whole new industry for the company.

"High-powered LEDs are the future of the lighting industry," Leonard said. "[In addition to the MagWerks applications], we've prototyped several military parts that are being developed. And as far as we know, only two investment casting sources in the U.S. can do magnesium."

The company's main customers in the medical industry manufacture prosthetics and medical equipment. Ziemba noted that some exciting magnesium innovations are developing within that field. "We also do a lot of prototype work for GM and Ford," Leonard said. Magnesium is used in many aircraft parts, and Aristo-Cast has done some interesting work in propulsion parts.

"I read an interesting fact: If you can cut 500 pounds off a commercial airliner, it will save one quarter of a million dollars in fuel over a year," Ziemba said. "There are a lot of exciting things happening with magnesium."

Looking Ahead to Production

When in high-volume production, the MagWerks LED lamps most likely will be injection molded, not investment cast. Thixotropic injection molding is a semi-solid diecasting process in which magnesium slurry is injected into a steel die. Advantages include long die and chamber life, fine-grained castings with few defects and minimal loss of metal fed to the machine.

One of Aristo-Cast's strengths is its ability to produce prototypes that match the production design that would be used for high volumes. "Not only can we meet or exceed the physical properties that would be obtainable by Thixomolding or regular diecasting, but we can exactly duplicate what they're going to do as far as the tooling is concerned," Ziemba said.

Depending on the part, Aristo-Cast can produce an investment cast product at 20% of the tooling cost of a diecast tool.

MagWerks customer Sealink International bought aluminum lamps prior to working with Pickholz.

"We presented the [magnesium] technology and convinced them to develop a concept and prototype," he said. Three years later, the companies' first LED lamp has been through the step-by-step process of development, prototyping and production validation products. Currently, the lamp is being evaluated by major car manufacturers.

Steel and aluminum are large players in the automotive industry, and Pickholz noted the challenge of presenting an entirely new product to clients.

"There are a lot of misconceptions surrounding magnesium, such as that it burns, costs a lot and is very hard to get," Pickholz said. "So you have a very steep learning curve that you

Aristo-Cast produced the prototype for MagWerks' AZ91E magnesium alloy LED lamp using the investment casting process.

have to overcome through demonstration and proof. Magnesium is very easy to get, and solid magnesium does not burn." In addition, he noted that durability is not a concern, even with the thinner walls of these LED lamps.

According to Pickholz, the advantage of magnesium alloys is a combination of three elements: "You can do much lighter mass, which is critical to automotive and transportation as a whole; you can produce at a lower cost; and you can create a better product." MC

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