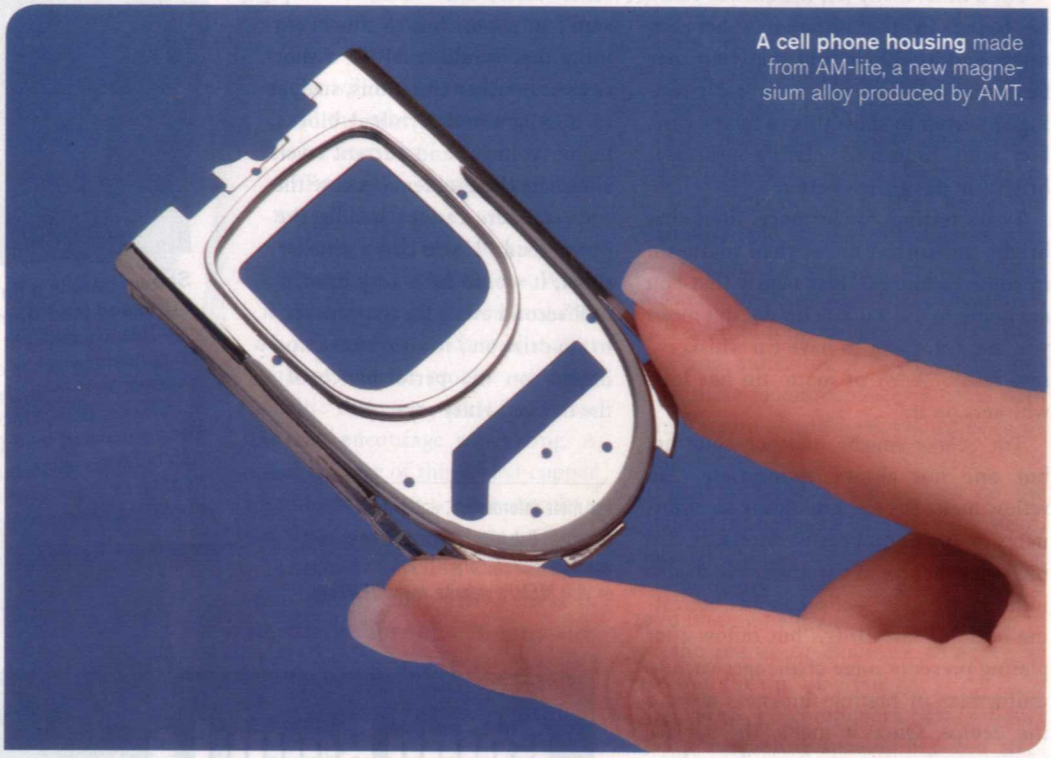
MERITABLE MAGNESIUM



A cell phone housing made from AM-lite, a new magnesium alloy produced by AMT.

New casting alloy provides both strength and beauty.

by larry adams

While plastic still dominates as the material of choice for electronic housings, more designers are looking at metal die castings as an alternative that delivers higher strength and inherent electromagnetic shielding. Where weight is a concern, magnesium is often chosen for its lightness.

Designers thinking about this option might take a look at a new magnesium alloy that developers say has high diecastability, is lightweight and strong, can be easily electroplated, finishes well, and has the potential to cut material, recycling and production costs.

This light and strong magnesium alloy is called AM-lite. It is produced by Advanced Magnesium Technologies (AMT) of Milton, Australia, and was developed serendipitously in conjunction with the Australian CAST Cooperative Research Center in Australia. Researchers were looking for ways to develop a low-cost magnesium alloy that resisted deformation for use in engine blocks. It did not work for that purpose, but the researchers noticed that castings of the alloy exhibited a high quality "beautiful surface finish."

Magnesium market

Die casting is the biggest market for magnesium alloys. The alloys are often used in electronic housing and decorative applications because they are lightweight and durable. For instance, magnesium is about 1/4 the density of Fe (iron) and 2/3 the density of AL (aluminum).

Currently, the most popular magnesium product is the alloy AZ91D, but AMT says that this material tends to have high die-cast reject rates and surface finishing problems. Plus, it is difficult to electroplate.

Gordon Dunlop, General Manager, Technology Development for AMT, says that AM-lite is the first magnesium die-casting alloy that can be readily electroplated in mass production processes.

He adds that because the alloy is light, it can be die cast into thin, complex shapes, exhibits good surface finishing properties, and can reduce manufacturing costs and cycle times, and it is competitive against zinc, aluminum and magnesium AZ91D die castings and plastic injection moldings for decoratively finished parts.

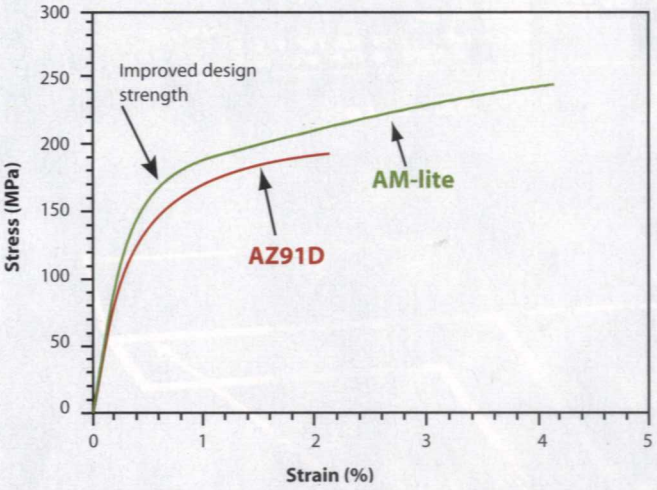


Fig. 1. Tensile curves for AM-lite and AZ91D. Source: AMT

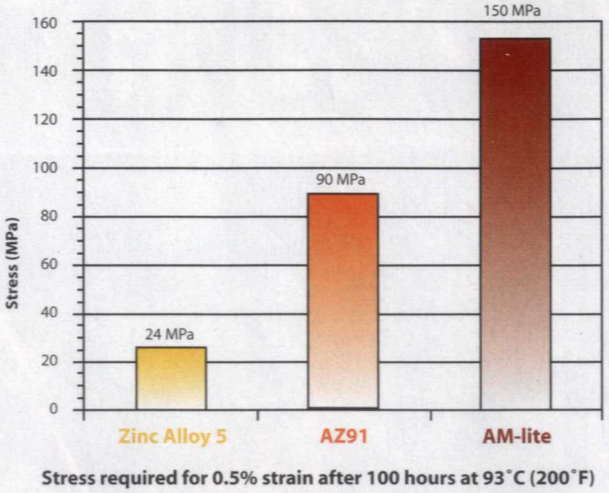


Fig. 2. Comparison of creep strength of AM-lite, AZ91D and zinc alloy 5. Stress required for 0.5 percent strain after 100 H at 93 DegC. Source: AMT

The magnesium die-casting alloy was first introduced to the market in June 2005. Over the past 12 months, AMT has presented the AM-lite technology to about 150 companies and at four industry conferences.

More than 40 industrial die-casting trials have been conducted in Europe, North America and Asia, and, according to Dunlop, these die-casting trials have backed up company claims about the AM-lite technology. AMT is working with nine customers (three each in Europe, North America and China) on product and process development with the aim of bringing a small number of products to the market before the end of 2006. Products currently under development are in the areas of electronics, hardware, and plumbing products.

Dunlop says there are at least two reasons that designers would want to incorporate AM-lite into their products. He says that the alloy improves stiffness, linear elastic limit and strength, allowing thinner parts to be designed. Also, the improved diecastability — in this case the ability to be cast into a very thin die — enables such thin parts to be manufactured. Depending upon design, thicknesses as low as 0.4 mm are possible in some parts.

This is especially important for electronic housings that need to be robust, light, highly decorative, and as thin as possible. Dunlop says that AM-lite has good conductivity and it provides EMI/RFI shielding that plastic materials, for instance, cannot attain without applying a metallic coating.

Essential properties

AM-lite has been designed to provide its surface with improved oxidation resistance compared to other magnesium alloys. This works to improve the diecastability and the quality of as-cast surfaces. The chemical composition of the surface enables the alloy to be electroplated using MacDermid's Bondable Mg process developed by German-based MacDermid GmbH, a global supplier of chemicals and technology to the surface finishing industry.

According to a white paper on the material co-authored by Dunlop, molten AM-lite exhibits good fluidity and that its diecastability is similar to that of zinc die-casting alloys, generally considered to be a material with high diecastability capabilities. A consequence of its diecastability is that it can faithfully reproduce fine detail from the die. Also, the studies have shown that AM-lite can reduce some die-casting defects such as cracking along flow lines, cold cracks, and hot cracks.

In comparison to other magnesium die-casting alloys, specifically AZ91D, AM-lite is oxidation resistant at temperatures in the range of solidification and below. According to Dunlop, this means that there is less oxide on the casting surface and shelf life is improved compared to castings of other magnesium alloys. This makes the material easier to recycle, he says.

Dunlop adds that the as-cast surface of AM-lite reduces the need for polishing and buffing prior to surface finishing operations and can eliminate the need for filling of sur-

Attribute	AM-lite	AZ91D	Zn Alloys 3 & 5
Cost Diecastings Surface finished	 60% 75%	 90% 150%	 100% 100%
Electroplating	Yes	No	Yes
Diecastability	Good	Fair	Very good
As-cast surface	Good	Poor	Very good
Surface coating	No filling Reduced buffing No blisters	Filling required Extensive buffing Blister defects	Blister defects
Density	2.0 g/cm^3	1.8 g/cm^3	6.6 g/cm^3
Design strength	100 MPa	40 MPa	15 MPa
Melt loss	~1%	~4%	~1.5%
Recycling	ok	costly	ok

Table 2. The table summarizes the properties of AM-lite relative to magnesium AZ91D and zinc die-casting alloys. Source: AMT

Property	AM-lite	AZ91D
Yield Stress, MPa 2 mm plates	160-170	120-150
UTS, MPa 2 mm plates	230-250	180-205
E - Modulus GPa	45	44
Elongation, % 2 mm plates	3-4	3-4
Linear elastic limit, MPa	~100	~40

Table 1. Mechanical properties of AM-lite die-casting compared to AZ91D using 2 mm thick plates. Source: AMT

face defects. Also, the alloy has creep resistance that restricts the expansion of gases during baking cycles and that makes it resistant to blister defects.

According to company testing, AM-lite exhibits better tensile and creep properties than magnesium AZ91D. In particular, it has a higher linear elastic limit that makes it more suitable for stiffness limited designs. In testing on 2 mm thick die-cast plates (see ***Fig. 1***), AM-lite maintained its linear elastic behavior to higher stresses than AZ91D. For AZ91D, the limit is ~40 Mpa, while for AM-lite it is 100 Mpa.

AM-lite also stands up well in terms of its creep properties, according to the company's testing. As shown in ***Fig. 2***, the creep strength of die cast AM-lite at temperatures of around 100 DegC is about 65 percent greater than AZ91D and 500 percent greater than a typical zinc die-casting alloy.

Comparing materials

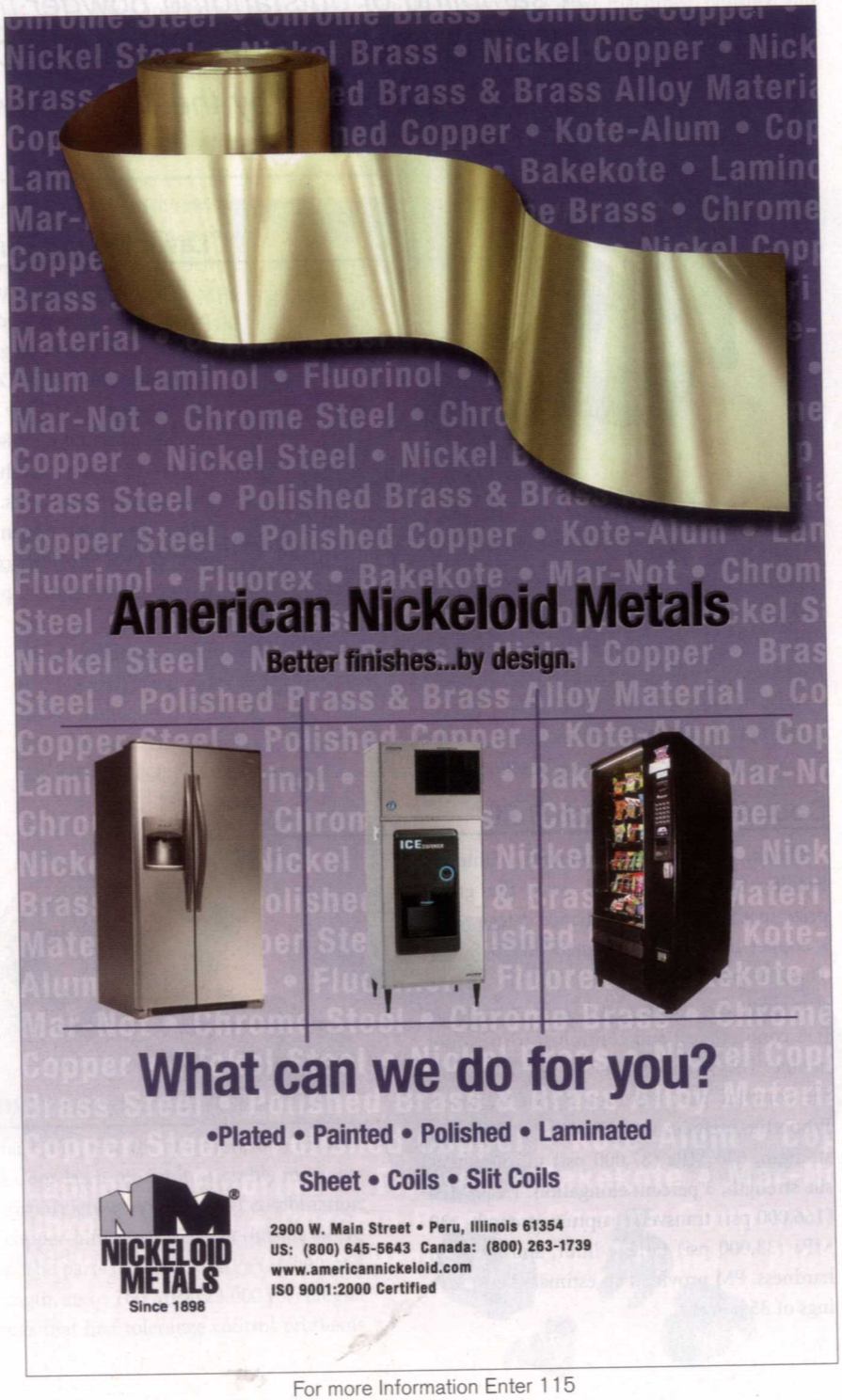
Dunlop says that AM-lite is a good alternative to a number of other materials. He says that zinc, for example, has tripled in price over the past 18 months. Compared against zinc, AM-lite offers about a 60 percent to 70 percent cost savings in material costs and 40 percent cost saving in the total cost of manufactured parts.

Compared against aluminum, more detailed parts can be produced in AM-lite with an estimated 12 percent to 30 percent saving on the cost of die cast parts. Dunlop says that this is largely because of lower metal costs, reduced cycle times, and longer die life.

AM-lite is preferred to plastics primarily because of its metallic feel (heat conductivity), but there are other advantages for design engineers because of its much greater stiffness. The cost of engineering plastics has increased significantly, providing further opportunities for cost savings with AM-lite.

He adds that, compared against AZ91D, the primary advantages are the ability to produce thinner die-castings with a better as-cast surface that can be readily electroplated. Reduced melt losses and improved recyclability offer cost savings. For precision, thin-walled parts, it is not uncommon that less than 10 percent of the quantity of magnesium entering the manufacturing process ends up in the finished parts. ■

For more information, enter **301**
Or email: *gordon.dunlop@am-technologies.com.au*



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