

Magnesium's Tough Strength Endures Abuse To Protect Portable Electronic Devices

Driven by environmental programs across the consumer electronics industry, portable electronics product manufacturers are opting for light, yet tough magnesium for everything from flash audio/video players to digital cameras, mobile phones, computer notebooks, radar detectors, and more. Magnesium meets the design challenges that are instrumental to consumer electronics becoming lighter, thinner, and more mobile. Components that house and protect highly sensitive technology inside these entertainment and communications devices must exhibit strength and durability to withstand daily abuse from being dropped, stepped on, bumped, banged around in transit, and survive even the ultimate test—teenagers.

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Making the Case: Portable Audio/Video Travels Light with Magnesium

The Philips GoGear SA52 portable digital audio/video player with magnesium housing lets consumers experience high-quality music and video content. © Photo courtesy of Royal Philips Electronics. Used with permission.



Perhaps the most critical aspect to electronic equipment endurance is selecting materials with a high strength-to-weight ratio. Electronics manufacturers, such as Royal Philips Electronics of Eindhoven, The Netherlands, know that their products must sustain stringent mechanical tests that challenge the limits of a material's ability to bend, twist, and be dropped while remaining intact.

In portable electronics products such as the GoGear SA9200 and SA9300 series flash audio/video players, the selection of magnesium alloy AZ91D allows Philips mechanical and product designers to integrate complex shapes using the molding flexibility of the die-casting and

Thixomolding™ processes. Secondary machining of the magnesium parts provides additional design freedom to achieve intricate cuts and various shapes with extremely tight tolerance requirements that are not possible with plastic molding.

Philips newest GoGear product, the SA52 portable audio/video player, incorporates magnesium casing into its sleek and sophisticated design. The tough magnesium housing protects Philips patented FullSound digital audio technology inside, which enhances sound quality of compressed MP3 audio files to create a symphony-like experience through high-definition headphones for richer, clearer sound. Philips relies on the strength of magnesium to keep their latest generation of advanced Digital Signal Processors functioning flawlessly.



The GoGear SA3315, fortified by magnesium casing, has a 2.4-inch color LCD screen, downloads from a PC, converts video files, and is a touch-controlled MP3 player with FM tuner and voice recorder. © Photo courtesy of Royal Philips Electronics. Used with permission.

Magnesium stands up to Philips' testing, including a bare drop of 130 centimeters, bend testing of 100 Newtons (N) force for 30 seconds on top side flat plane, display window press of 100N force for 30 seconds in the vertical direction of the LCD window, and a twisting test of 2 Newton meters (Nm) torque for 100 cycles. Such endurance extremes require a framing component that has the thinnest wall thickness possible, yet is strong enough to provide structural support for display integrity without cracking.

Strong and flexible enough to stand up to daily wear and tear, GoGear's magnesium alloy AZ91D middle frame housing components undergo fine punching, NC machining, as well as polishing and painting to achieve optimal part surface finish with a sandblast texture and a matte silver spray coating.

Making the Case: Digital Camera Focuses on Magnesium

A magnesium alloy body and chassis form the housing of the EOS 50D digital camera from Canon U.S.A., Inc. of Lake Success, New York. The EOS 50D is the digital imaging leader's newly introduced high-end SLR camera. The EOS 50D features a 3.0-inch LCD, 15.1 megapixel resolution and Canon's new DIGIC 4 image processor and Creative Auto Mode that enables all users to easily adjust image settings.

Canon's design engineers chose a magnesium alloy exterior because it enables sturdy go-anywhere photography for amateurs and professionals alike. The magnesium case incorporates upgraded moisture and dust resistance into its design making it impervious to weather and facilitating greater outdoor use. Weighing in at just 25.7 ounces (730 grams), the high-end EOS 50D SLR digital camera maximizes magnesium's light weight.



Canon's EOS D50 SLR digital camera has DIGIC 4 image processing, CMOS APS-C size image sensor, and enhanced Auto Lighting Optimizer technology all protected by strong, durable magnesium casing. © Photos courtesy of Canon, U.S.A., Inc. Used with permission.

Making the Case: Magnesium Well-Traveled in Notebook Protection

EliteBook notebook computers from Hewlett-Packard Company (HP), of Palo Alto, California, are designed to survive the daily abuse of business travelers with its DuraCase exterior, which combines a magnesium alloy chassis with casing that thermally bonds tough magnesium to an aluminum outer layer. The lightweight and ultra-thin EliteBook line, ranging from the 12.1-inch portable to the 17-inch notebook has powder-coated magnesium bases with aluminum-clad magnesium forming the entire panel display enclosure, defining HP's notebook category known as *Business Rugged*.

"We've chosen magnesium for its light weight, which is a key factor to notebook mobility and portability, in addition to its strength" said HP's business notebook product manager Jeremy Brody. "The use of magnesium for notebook enclosures affords us the ability to offer a very stiff and rigid assembly, fully protect key components, and ensure long-term product reliability without the burden of added weight."

The case structure features magnesium that is thermally bonded with brushed anodized aluminum. On the HP 2730p EliteBook tablet model, the base and display enclosure are powder-coated magnesium.

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Die-Cast Technique Enhances Product Wear and Durability

The high-impact strength of die-cast magnesium alloy parts translates to durable, high-end electronics housings. Designers frequently specify die-casting because it is cost-effective and offers manufacturers a broader range of shapes and configurations than other forming techniques. Die-cast components offer a long service life and work well in tandem with the designs of adjoining parts.

The die-casting process injects the molten magnesium alloy into a steel die under high pressure, until it solidifies into the molded shape's metal part. Modern die-casting uses computer-controlled precision to rapidly produce high-strength magnesium products in a variety of intricate designs made to close dimensional tolerances. New process techniques, such as high-pressure casting, squeeze casting, and semi-solid die-casting expand near net-shape casting capabilities, producing high structural integrity parts with exceptional surface finishes.

Hot-Chamber Method Improves Magnesium Cast Products

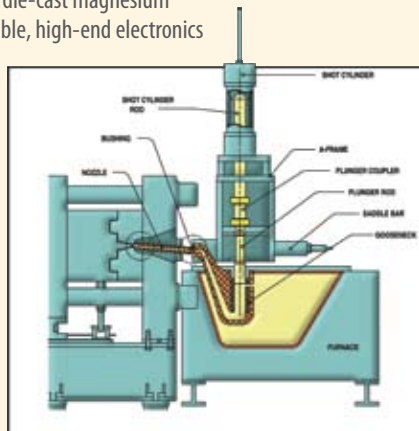


The die-casting industry heavily incorporates recycled magnesium content into new castings without any loss in quality. © Photo courtesy of Chicago White Metal Casting, Inc. Used with permission.

Hot chamber die-casting machines are ideal for magnesium alloys due to the metal's low melting point.

Hot-chamber die-casting technology maintains molten metal temperature at the die entrance, needing less than half the injection pressures required for cold-chamber technology. In a hot chamber casting machine, the die injection mechanism is within a molten metal bath in the metal holding furnace, attached by a gooseneck metal feed system. Molten magnesium enters when an injection cylinder port opens, filling the cylinder. Downward plunger motion seals the port, forcing molten magnesium alloy through the gooseneck and nozzle into the die cavity where it solidifies; the casting is ejected when the die opens.

Hot-chamber technology correlates to reduced defects in the cast magnesium products. Lower porosity and flow defect levels improve the casting's mechanical properties, enhancing process efficiencies and making secondary machining and finishing easier.



Hot-chamber die-casting is the preferred newer method for manufacturing magnesium power tool housings. Complex, thin-walled castings can be made to precise tolerances with few defects and with minimal or no machining required.

© Diagrams courtesy of the North American Die Casting Association. Used with permission.

During the die-casting process, magnesium is formed into highly complex and thin-walled parts with high precision, making it the ideal metal for this process. Newer hot-chamber magnesium die-casting methods improve material yield and significantly shorten process cycle time, offering high process stability, cost efficiency, and reduced waste compared to traditional cold-chamber die-casting methods.

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According to Chicago White Metal Casting, Inc., Bensenville, Illinois, lightweight magnesium die-cast housings are replacing failed plastic housings. The die-casting industry takes full advantage of magnesium's recyclability, using recycled content materials to create new die-castings, ultimately saving significant energy. At the end of a die-cast magnesium product's life cycle, the alloyed metal is easily reclaimed and recycled into newly manufactured components without any loss in quality. Reuse and recycling of magnesium products demonstrates the die-casting industry's commitment to environmental responsibility and preserving resources.

Thixomolding™ Shapes Magnesium for Innovative Electronics Applications

The numerous advantages of Thixoforming manufacturing combined with the inherent benefits of magnesium make a powerful duo for producing strong but lightweight component parts to protect valuable consumer electronics. Thixoforming combines the shape-making capabilities of injection molding with conventional die casting technology, feeding chipped material through a heated, multi-zone barrel where it transforms magnesium alloys into a semi-solid (thixotropic) state, and is then injected into a mold. The material has an inherently refined microstructure and enhanced material properties.

Thixomolding™ produces thin-walled shapes with ease, and is well-suited for cell phones, hand-held devices, and laptop components that demand very high cosmetic requirements. Long tooling life is an advantage of Thixomolding that yields excellence in surface requirements. Allan Totten, Thixoforming Sales Manager for Precision Cast Corporation/Advanced Forming Technology (PCC/AFT) of Longmont, Colorado, notes Thixomolding's environmental advantage, "In Thixomolding, depending on the molding machine size, anywhere from approximately 5 to 20 pounds of semi-solid magnesium is being melted. All of that material is inside an argon-protected environment. There are no greenhouse gases, much lower oxidation, and less ambient heat for operators to be exposed to ... a very green way to manufacture magnesium components."

Thixomolding of magnesium not only achieves high levels of complexity and net shape, but excellent EMI/RFI shielding, high strength, tight tolerances, and thin wall capabilities, according to an expert company in the field of magnesium mobile phones, the Magnesium Precision Co., Ltd. (MGP), of Hiroshima, Japan, a subsidiary of Japan Steel Works (JSW), Tokyo. MGP supplies Thixomolded parts to the world's leading cell phone makers.

Kazuo Kitamura, mobile phone expert for JSW notes: "The most important reason to use magnesium for mobile phone frames is its rigidity and stiffness, to protect the LCD screen. Thixomolding can achieve higher pressure than die casting, resulting in a much better surface."

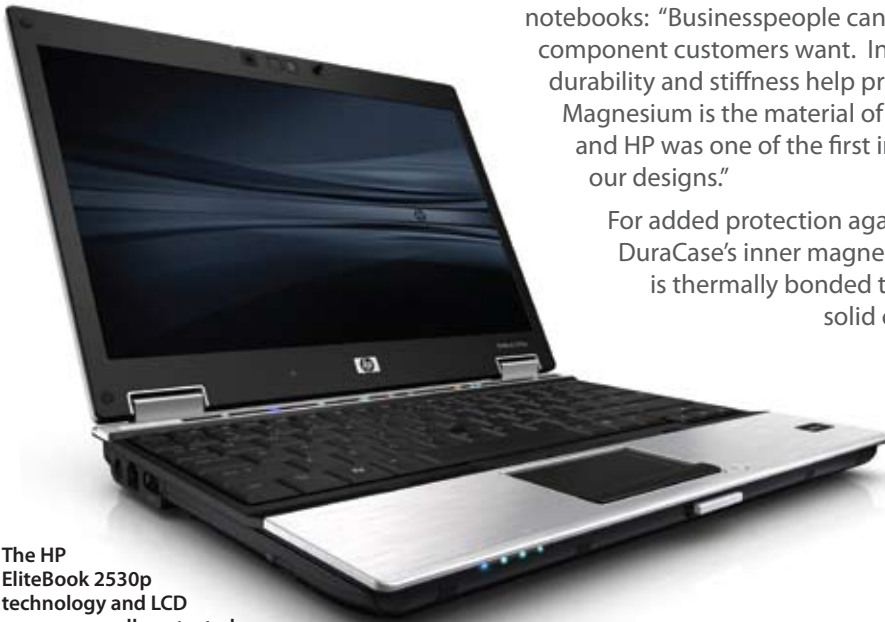


The Valentine One® Radar Locator, housed in lightweight yet rigid Thixomold magnesium, has front and rear radar antennas reporting to an onboard computer. This system enables the Valentine One to locate and analyze all radar sources from ahead and behind vehicles. © Photo courtesy of Valentine Research, Inc. Used with permission.



These Thixomolded magnesium alloy AZ91D cell phone frames are designed to provide long life and durability, and are in demand by the world's top cell phone makers. © Photo courtesy of Magnesium Precision Co., Ltd./Japan Steel Works. Used with permission.

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The HP EliteBook 2530p technology and LCD screen are well-protected by the magnesium base and aluminum-clad magnesium case and display enclosure. © Photo courtesy of HP. Used with permission.

Brody notes that today's business customer is looking for magnesium in their notebooks: "Businesspeople can't afford downtime, so magnesium is the component customers want. In addition to light weight, magnesium's durability and stiffness help protect the display from expensive repairs. Magnesium is the material of choice for notebook structural elements, and HP was one of the first in the industry to utilize magnesium in our designs."

For added protection against damage from mishaps, the DuraCase's inner magnesium shell has a honeycomb pattern that is thermally bonded to the anodized aluminum layer for a solid construction that withstands active day-to-day use on the road. According to Brody, the HP EliteBook 2530p and 6930p are engineered to pass several military standard durability tests for extreme high temperatures, dust, vibration, shock, humidity, and drop testing from 30 inches.

In addition to light weight, magnesium's durability and stiffness help protect the display from expensive repairs.



HP's DuraCase consists of an anodized aluminum top layer, thermally bonded to magnesium with a weight relief hole pattern, which protects the notebook's display while minimizing weight impact. © Photo courtesy of HP. Used with permission.

Why Magnesium?

In addition to magnesium's excellent strength-to-weight ratio for die-cast components, the ultra-light metal offers 100 times better heat dissipation than plastics, the best vibration dampening of any metal, ease of machining, electromagnetic shielding, and the major environmental advantage of being recyclable.

Fast Facts

- » Strength-to-weight ratio, rigidity and durability make magnesium the ideal material to house consumer electronics
- » Long service life and recyclability make magnesium an eco-friendly choice for consumer electronics manufacturers
- » Tough magnesium cases protect advanced technology inside devices, as well as framing sensitive LCD displays
- » Magnesium alloy framing, chassis and case components survive extreme endurance tests for resistance to heat, dust, humidity, shock, drops, vibration, and pressure
- » Magnesium lends itself to the hot-chamber die-casting process to yield thinner, more complex-shaped housings that are precision cut to tight tolerances.



To learn more about the benefits of designing products with magnesium, contact the **International Magnesium Association**
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