

Magnesium: The Framework for Innovation

Across the board, eco-conscious design innovations take more than just bright ideas – they require materials that support and facilitate optimal energy efficiency and longer product life cycles. Magnesium alloys accomplish this while being fully reusable and recyclable. From Light Emitting Diode (LED) lighting to lighter vehicles that reduce an engine's load, to housing longer-life batteries in computers and electric personal transport, magnesium is becoming the designer's most versatile material choice to enhance product functionality and improve user mobility with greater energy efficiency and environmental benefits.

Magnesium Lighting the Way

Sustainable function and contemporary design combine in the ingenious LED portable light made by AltusLumen, Hong Kong, China. The light's entire housing is constructed of magnesium alloy AZ91D. AltusLumen's TRI-L portable LED is a convenient rechargeable lithium-ion battery light with intelligent power management, featuring a three-dimensional hinge that adjusts to any lighting angle. The ultra-bright and efficient LED light runs for several hours on a single charge, and may be charged by solar panel with an optional solar charger.



The magnesium swivel hinge and foldable tripod stand make the TRI-L LED portable light a hands free, go anywhere device. © Photo courtesy of AltusLumen. Used with permission.

According to product development manager Bill Tsang, AltusLumen chose magnesium for the TRI-L's case because magnesium conducts heat generated by the LED light away from the LED bulb, extending its usable life. Tsang notes, "Magnesium is one-third lighter in weight, making it a better choice than aluminum for outdoor activities that require a portable lighting device. In addition, only magnesium provides the strength required to produce the unique feature of a three-dimensional swivel hinge."

The LED light component is screwed into the magnesium housing, with upper and lower housings joined by a metal pin, force fitting upper and lower housings together. The magnesium housing is cast via injection. After parts are injected, CNC machining removes extra material. Holes are then drilled into the housing for mounting and the magnesium is powder coat painted.

The pocket-size portable light follows the company's guiding sustainability principles that include energy efficiency, using renewable energy, and choosing materials that are recycled and recyclable. AltusLumen engineer and TRI-L project manager Samuel Ng confirms the recycling benefits of AZ91D. Says Ng, "Magnesium is one of the few materials that can be endlessly recycled without degradation. Magnesium is easier to recycle and its value makes it an attractive material to recycle."



The TRI-L's magnesium pocket-size folding case, 110 x 60 x 20 millimeters, weighs only 140 grams and features a secure magnesium twisting hinge mechanism. © Photos courtesy of AltusLumen. Used with permission.

Magnesium Housing Enhances LED Flood Light Efficiency



LEDtronics, Inc., of Torrance, California, also chooses magnesium alloy housing for its energy-efficient LED warm-white and pure-white frosted soft flood lights. The PAR38 Series fixture's sturdy magnesium alloy construction weighs only 1.42 pounds, and maintains high shock and vibration resistance. LEDtronics Marketing Manager Jordon Papanier explains: "Proper thermal management pulling heat away from the LED chip is required to maintain light output and the long life aspects of LEDs. Thermal management performed using the magnesium housing offers the best heat sinks, even better than copper." The long-life LED flood light is used for signage, architectural and landscape lighting, security, aviation, industrial equipment, medical, and theatrical lighting.

The PAR38 Series LED flood light features a magnesium alloy body in a solid-state design that facilitates energy savings of up to 85 percent compared to incandescent flood lights. © Photo courtesy of LEDtronics Inc. Used with permission.

Magnesium Liftgate Improves Fuel Economy

The Lincoln MKT luxury crossover vehicle made by Ford Motor Company, Dearborn, Michigan, features an industry first: manufacturing a two-piece magnesium and aluminum rear liftgate construction that optimizes structural strength to meet safety requirements, while improving fuel economy by reducing component weight.

Strategic use of lightweight and down-gauged material allows a vehicle's powertrain to be smaller and more fuel-efficient. Combining magnesium with aluminum for the MKT liftgate's panels instead of steel saves 22 pounds in vehicle weight. When coupled with other weight-saving measures, re-matching the vehicle with a smaller powertrain – known as *right-sizing* of power to weight -- is a key factor in achieving greater fuel economy.



The Lincoln MKT liftgate design uses magnesium and aluminum panels to create a liftgate that is 40 percent lighter than a standard steel liftgate. © Photos courtesy of Ford Motor Company. Used with permission.

The Lincoln MKT is the first North American production vehicle to apply this innovation in the liftgate. Ford Product Development and Closures Chief Engineer Randy Frank puts the liftgate design innovation in context: "The MKT's liftgate is a breakthrough achieved by our scientific research team, product design team and our supplier, who overcame significant technical challenges to develop it. The use of magnesium and aluminum in the MKT marks a new direction for liftgates and closures in general."

Magnesium Casting Creates Design Advantage

Greater design flexibility is achieved by marrying the cast magnesium inner component to the aluminum outer panel, allowing a smoother transition from liftgate to bumper. Ford engineers met the MKT liftgate design challenge using Computer-Aided Engineering (CAE) modeling to develop what they consider the largest thin-walled magnesium closure panel in the North American vehicle industry.

The magnesium die casting process allows part thickness and shape to be fine-tuned to a degree not possible using stamped sheet metal. Ford Product Development Design and Release Engineer of Liftgates, Cindy Wetzel, says: "Because the magnesium liftgate inner is cast instead of stamped, we were able to develop variable thicknesses. We did extensive CAE analysis to see how the magnesium would functionally perform in a high impact event and made structural improvements such as ribbing for added strength."

The MKT engineers stress that although magnesium raw material cost is more than steel, an all-steel liftgate would be much more complicated and expensive to manufacture than the magnesium/aluminum liftgate, and too heavy for power lift systems to open. Magnesium not only accomplishes Ford's weight reduction goals, it creates new design options. Ford plans to continue reducing vehicle weight by 250 to 750 pounds to help meet strict fuel economy targets without compromising vehicle safety or durability.



The cast magnesium inner panel, shown in light gray, varies in thickness from 2mm at the thinnest spot, to 7mm at its thickest area. The aluminum outer panel is shown in blue. © Graphic courtesy of Ford Motor Company. Used with permission.

Magnesium Enhances Convenience & Mobility

Designers of the Lenovo ThinkPad X-Series notebook computer use magnesium alloy for the X201 laptop's bottom cover and the X201 tablet's top and bottom covers. Lenovo, Research Triangle Park, North Carolina, touts the Energy Star® 5.0-compliant X201s as the thinnest, lightest ThinkPad notebooks available with help from materials like magnesium.

Mika Majapuro, Lenovo's Worldwide ThinkPad product manager says, "Lighter than aluminum, the magnesium alloy provides extreme strength and light weight – a combination that enables us to design more ultra-portable PCs for mobile workers. The magnesium alloy material is recyclable and allows for the use of less material."

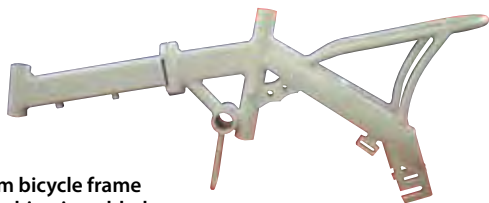


Lightweight magnesium alloy optimizes the Lenovo X201 laptop and X201 tablet's toughness and portability for today's mobile workforce. © Photos courtesy of Lenovo. Used with permission.

Lenovo engineers have chosen magnesium to house their cutting-edge technology. Magnesium covers make the Lenovo X201 and X201 tablet extremely durable yet lightweight with a small footprint, and are designed to pass eight military specifications tests: physical shock, thermal shock, altitude, dust, vibration, humidity, heat, and cold. Professionals in many fields use the X201 to enhance mobility, boost productivity and reduce overall ownership costs. The energy-efficient X201 tablet notebook is ultra-portable, featuring extra-long battery life of up to eight hours, weighing 3.57 pounds with a four-cell battery, and 3.95 pounds with an eight-cell battery. The optional multi-touch panel allows two-finger gestures to pan, zoom, rotate, right-click, and jot down and digitize handwritten notes, in addition to standard touch-screen features.

Electric Bike Rides Longer & Lighter with Magnesium

Electric bicycles are getting an eco-boost from AM61-series magnesium alloys by virtue of extruded tube and bar framing. The Hengshui Yuanyuan Light Alloy Company Ltd., Hengshui City, China, cites several advantages of magnesium alloy over aluminum for their electric bikes: specific gravity is smaller, saving electrical energy and prolonging the lithium-ion battery life; higher specific strength handles load demands with smaller thickness tubing; greater modulus of elasticity allows greater impact and sound absorption; less deformation with magnesium for superior dent resistance; and magnesium's vibration damping ability are all important benefits for electric bicycles.



Magnesium bicycle frame extruded tubing is welded, spray finished and assembled prior to attaching battery. © Photo courtesy of Hengshui Yuanyuan Light Alloy Company, Ltd. Used with permission.

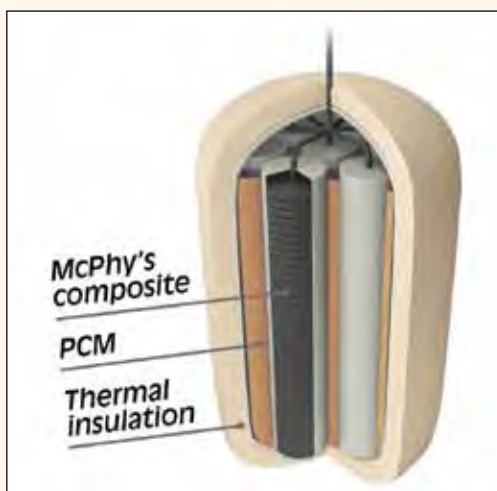


This electric bicycle achieves extended battery life and runs longer on a single battery charge due to the ultra-lightness of magnesium. © Photo courtesy of Hengshui Yuanyuan Light Alloy Company, Ltd. Used with permission.

The bike's magnesium alloy main frame and luggage carrier components are welded together, and then attached to other bike components with screws. Since lightweight magnesium alloy substantially reduces the bike's weight, its battery unit powers far less weight, thus extending the battery's useful life. Choosing magnesium alloy also supports Hengshui Yuanyuan Light Alloy's environmental goals because it is 100 percent recyclable, and uses less energy during the recycling process than other metals.

A Closer Look: Magnesium Aids in Storing Hydrogen Energy

Magnesium powders used to form magnesium hydrides (MgH_2) enable the storing of hydrogen solids. New hydrogen storage technology from McPhy Energy S.A., LaMotte-Fanjas, France, allows sustainable energy resources to be cost-effectively harnessed for later use. Electricity from energy sources such as solar collectors is converted using an electrolyzer into hydrogen and oxygen. Using magnesium hydrides to store solid hydrogen (H_2) in tanks for later input into the energy grid is a technological breakthrough that engineers at McPhy Energy have developed working with the National Center for Scientific Research (CNRS) laboratories in Grenoble, France, and experts from Joseph Fourier University in Grenoble.



This storage tank uses disks formed using magnesium hydrides to store solid hydrogen energy for later use. © Graphics courtesy of McPhy Energy S.A. Used with permission.

Magnesium's role in this hydrogen storage breakthrough has been critical. McPhy Energy board member Michel Jehan explains how the magnesium is processed: "From magnesium powders, we produce MgH_2 in about a 100 micron size. Then we grind the powder with special transition metal additives within highly reactive ball grinders down to less than one micron in size, under a reactive blend of gas containing H_2 . We transfer the reactive powders and blend them with carbon material, then press the material into large disks. The disks become the storage material for the hydrogen, and are packed into pipes that resist up to 15 bars of pressure within the storage tanks."

McPhy Energy chose magnesium hydrides to create the means for safe, reversible hydrogen storage with much greater energy efficiency and no compression required. Storing hydrogen in the form of MgH_2 has practical advantages, since one cubic meter of magnesium contains 110 kilograms (kg) of atomic hydrogen when formed as MgH_2 at the pressure of the water electrolyzer, compared to the expensive process of using one cubic meter of liquid hydrogen to yield 70kg of hydrogen. Storing very stable MgH_2 in insulated tanks provides a cost-effective way to reserve large quantities of hydrogen energy that will be easily converted back into fuel cells and to the energy grid.

McPhy's work with the CNRS to refine the kinetic absorption and desorption reactions of hydrogen with magnesium has drastically reduced conversion time from hours to just minutes for hydrogen loading and unloading operations. McPhy's storage tanks typically house hydrogen for grid-generated electricity, and for the transportation industry as the hydrogen fuel cell supply for bus, SUV or van fleets. McPhy's patented processes and machinery to mass produce powdered MgH_2 and the tanks used to store solid H_2 are rapidly advancing the use of hydrogen power in the global energy mix.



To learn more about the benefits of designing products with magnesium, contact the **International Magnesium Association**
1000 N. Rand Road, Suite 214, Wauconda, IL 60084 USA
Tel. 847.526.2010 • Fax 847.526.3993 • E-mail: info@intlmg.org • www.intlmg.org

© 2010, International Magnesium Association

IMA: The global voice of the magnesium industry