

EXPERTS IN MAGNESIUM



LUXFER[®]
MAGNESIUM
ROLLED PRODUCTS



SATELLITE & SPACE



DEFENSE



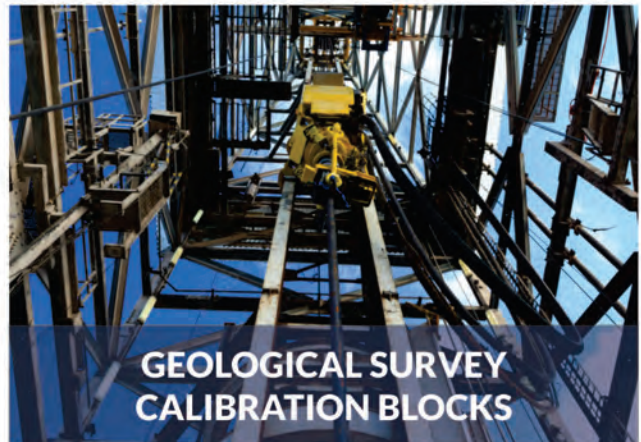
AEROSPACE



END-OF-ARM TOOLING (EOAT)



VIBRATION TEST EQUIPMENT



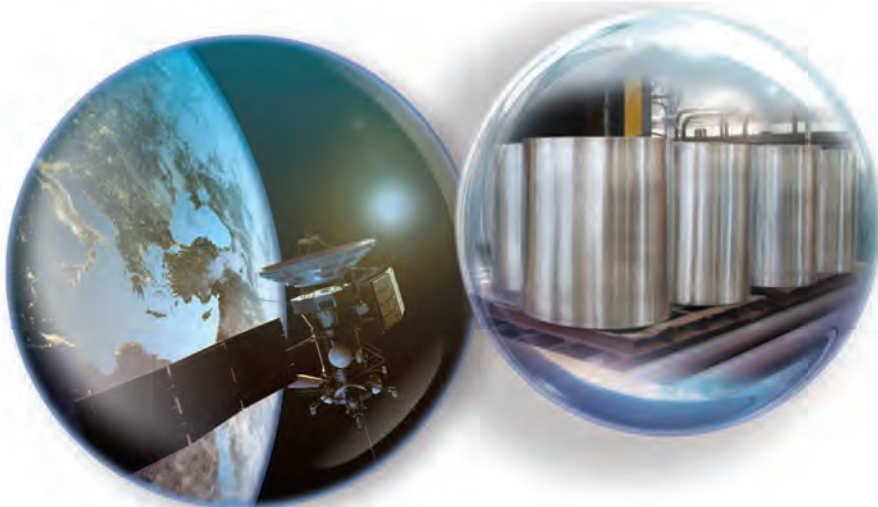
**GEOLOGICAL SURVEY
CALIBRATION BLOCKS**

The Global Leader in Magnesium Plate and Sheet Technology

WHY USE MAGNESIUM?



- Lightest structural metal with a density of 1.74g/cm^3 --a 33% weight reduction compared to aluminum at a density of 2.7g/cm^3 and a 75% weight reduction compared to steel at 7.85g/cm^3
- Easily formed and can be dry free machined with less power, more speed, and less tool wear
- Free machining (even dry) with less power, more speed, and less tool wear
- Can be TIG, MIG, and friction stir welded
- Modern alloys have enhanced corrosion resistance
- The 8th most abundant element, 2% of earth's crust, and the 3rd most plentiful element found in sea water
- Superior formability at only 300C, allowing for less spring-back and greater draw depths
- **Dent Resistance:** Superior to aluminum sheet when used in automotive panels, cell phones, laptops and camera cases
- **Corrosion Resistance:** Alkali resistant. In normal atmospheres, corrosion rate of uncoated metal is lower than iron or steel. In severe environments, superior coating and finishing systems are available to prevent galvanic corrosion of components
- **Toxicity:** Non toxic. Fourth most abundant element in the body. The body requires 400mg per day of magnesium for 300 biochemical reactions, including carbohydrate metabolism (Also the main element behind plant photosynthesis; key to cellular function)
- **Environment Friendly:** Virtually limitless supplies in seawater. Endlessly recyclable at 5% of the initial refinement energy, without degrading of properties



ALUMINIUM VS MAGNESIUM

Features	AL 6061		AZ31B		Elektron 43	
Chemical Composition	Magnesium	0.8-1.2%	Aluminum	2.5-3.5%	Yttrium	3.7 4.3%
	Silicon	0.4-0.8%	Zinc	0.7-1.3%	Rare Earths	2.3 - 3.5%
	Copper	0.15-0.40%	Manganese	0.20-1.0%	Zirconium	0.2% min
	Aluminium	Balance	Magnesium	Balance	Magnesium	Balance

Physical Properties			
Specific Gravity	0.098 lbs/in3 (2.72g/cm3)	0.064 lb/in3 (1.78g/cm3)	0.068 lbs/in3 (1.83g/cm3)
Coefficient of thermal expansion	12.5x10 ⁻⁶ °F (68.37x10 ⁻⁶ K)	4.9 x 10 ⁻⁶ °F (26.8 x 10 ⁻⁶ K)	4.7 x 10 ⁻⁶ °F (25.6 x 10 ⁻⁶ K)
Specific Heat	0.22 Btu/lb/°F (915.2 J/kg/K)	0.25 Btu/lb/°F (1040 J/kg/K)	0.24 Btu/lb/°F (993 J/kg/K)
Thermal Conductivity	83 Btu/hr/ft2/°F (143.4 W/m2/K)	44.5 Btu/hr/ft2/°F (76.9 W/m2/K)	33.3 Btu/hr/ft2/°F (57.6 W/m2/K)
Modulus of Elasticity	68.9 Gpa	44 GPa	44 GPa
Poissons Ratio	0.33	0.35	0.295
Melting Range	1080-1205°F (582-652°C)	1050°F - 1170°F (566° - 632°C)	1004-1184° F (540 - 640° C)

Density			
Fracture Elongation	10%	8%	12%
Tensile Yield Strength	36ksi	22ksi	33ksi



AZ31B MAGNESIUM SHEET, PLATE & COIL



AZ31B Benefits

Lightweight:

33% lighter than aluminum
75% lighter than steel

Easy machining

40% faster than Al 6061
96% faster than Al 7075

Longer tool life

5 to 10 times longer tool life
when compared to aluminum

Good damping properties

AZ31B Applications

- Aerospace/rotorcraft
- Space/satellites
- Defense
- Automotive/motor sport
- Computer/cell phone/camera housings
- Electrical housings
- Medical equipment
- Orthopedic braces
- Robotics

MACHINING

Magnesium machines faster than any other known metal. The machining rate of magnesium is limited only to the speed of the cutting tool. Studies have shown that magnesium machines 40% faster than 6000 series aluminum and up to 96% faster than 7000 series aluminum, and can withstand large feed rates and great depths of cut. Magnesium acts similar to wood when machined and produces well-broken chips that do not accumulate on the cutting tool, allowing magnesium to require 55% less cutting power as compared to aluminum.

SURFACE TREATMENT

The protective surface treatment required by AZ31B is dependent on the service conditions where the material will be operating. In dry conditions with limited exposure to moisture, AZ31B can be left bare or lightly oiled. A protective coating solution should be given to applications in more demanding environments. AZ31B can be protected by a variety of coatings that include chromating, anodizing, plating, e-coat, paint, and plasma electrolytic oxidation (PEO). It is recommended to prepare the magnesium surface by cleaning and pre-treatment (conversion coating) using traditional non-ferrous methods prior to e-coat or paint. There are commercially available pre-treatments that are non-chromate based chemistries which result in good adhesion of the paint system. For further guidance on surface protection, contact Luxfer MRP.

WELDABILITY

AZ31B is excellently weldable using GSA (gas shielded arc) welding using AZ61A (preferred) or AZ92A filler rod. Post-weld stress relief annealing is required to prevent cracking. AZ31B sheet and plate can also be FSW (friction stir) welded.



AZ31B MAGNESIUM SHEET, PLATE & COIL - PROPERTIES

CHEMICAL COMPOSITION

Aluminum	2.5-3.5%
Zinc	0.7-1.3%
Manganese	0.20-1.0%
Magnesium	Balance

PHYSICAL PROPERTIES

Specific gravity	0.064 lb/in ³ (1.78g/cm ³)
Coefficient of thermal expansion	4.9 x 10 ⁻⁶ /°F (26.8 x 10 ⁻⁶ /K)
Specific heat capacity	0.25 Btu/lb/°F (1040 J/kg/K)
Thermal conductivity	44.5 Btu/hr/ft/°F (76.9 W/m/K)
Modulus of elasticity	6500 ksi (44 Gpa)
Poissons ratio	0.35
Melting range	1050°F - 1170°F (566° - 632°C)

MECHANICAL PROPERTIES

Gauge inches (mm)	Temper	Tensile Strength ksi (MPa)	Yield Strength ksi (MPa)	Elongation
.040-.050" (1-1.51)	-O	32 (221)	18 (124)	12%
.060-0.49" (1.52-12.6)	-O	32 (221)	15 (103)	12%
0.5-1.99" (12.7-50.8)	-O	32 (221)	15 (103)	10%
2"-3" (50.8-76.2)	-O	32 (221)	15 (103)	9%
.040-0.249" (1-6.32)	-H24	39 (269)	29 (200)	6%
0.25-0.374" (6.32-9.5)	-H24	38 (262)	26 (179)	8%
0.375-0.5" (9.5-12.7)	-H24	37 (255)	24 (165)	8%
0.5-1" (12.7-25.4)	-H24	36 (248)	22 (152)	8%
1-2" (25.4-50.8)	-H24	34 (234)	20 (138)	8%
2-3" (50.8-76.2)	-H24	34 (234)	18 (124)	8%

AZ31B meets these specifications: AMS 4377, AMS 4375, AMS 4382 and ASTM B90

Domestically Made / DFARS Compliant / RDHS Compliant / Frank Dodd Act Compliant



ELEKTRON 43 PLATE



ELEKTRON 43 Benefits

Flame Resistant

Non burning
Lightweight

33% lighter than aluminum

75% lighter than steel

High Strength

Creep Resistant

Easy Machining

40% faster than Al 6061
96% faster than Al 7075

Elektron 43 Applications

The isotropic properties of Elektron 43 make it well suited for use in machining high performance components, particularly those for elevated temperature applications. The high specific stiffness and good ductility of the alloy makes it an ideal metallic material for achieving weight reduction in applications that would traditionally employ high strength aluminum alloys.

MACHINING

Magnesium machines faster than any other known metal. The machining rate of magnesium is limited only to the speed of the cutting tool. Studies have shown that magnesium machines 40% faster than 6000 series aluminum and up to 96% faster than 7000 series aluminum, and can withstand large feed rates and great depths of cut. Machining magnesium uses 55% less power than what is required to machine aluminum. Magnesium machines like wood with well broken chips and does not accumulate on the tooling as compared to aluminum alloys. Extremely fine and smooth surfaces can be achieved and 5 to 10 times longer tool life can be expected.

SURFACE TREATMENT

The surface protection of Elektron 43 is dependent on the service conditions where the material will be operating. In dry conditions, with limited exposure to moisture, Elektron 43 can be left bare or lightly oiled. A protective coating solution should be given to application in more demanding environments. Elektron 43 can be protected by a variety of coatings that include chromating, anodizing, plating, e-coat, paint, and plasma electrolytic oxidation (PEO). It is recommended to prepare the magnesium surface by cleaning and pre-treatment (conversion coating) using traditional non-ferrous methods prior to e-coat or paint. There are commercially available pre-treatments that are non-chromate based chemistry which result in good adhesion of the paint system. For further guidance on surface protection, contact Luxfer MRP.

FLAME RESISTANT

Elektron 43 is a flame resistant alloy. It meets the flammability requirements set out in the FAA's Aircraft Materials Fire Test Handbook DOT/FAA/AR-00/12 for commercial aircraft. The unique alloy content of Elektron 43 produces flammability resistance comparable to aluminum while in bulk form. This resistance is the result of a robust surface oxide formation that increases Elektron 43's Pilling-Bedworth (P-B) ratio to a non-burning 1.39 from pure magnesium's burnable 0.81. Elektron 43's flame resistance makes it the alloy of choice.

MINIMUM TENSILE PROPERTIES

INCH/POUND UNITS

Nominal Thickness inches	Tensile Strength ksi	Yield Strength at 0.2% Offset ksi	Elongation in 4D %
1.00 to 1.50 incl.	44	33	12
Over 1.50 to 6.0 incl.	47	30	6

MINIMUM TENSILE PROPERTIES

SI UNITS

Nominal Thickness inches	Tensile Strength MPa	Yield Strength at 0.2% Offset MPa	Elongation in 4D %
25.4 to 38.1 incl.	303	228	12
Over 38.1 to 152.4 incl.	324	207	6

CHEMICAL COMPOSITION

Yttrium	3.7 - 4.3%
Rare Earths	2.3 - 3.5%
Zirconium	0.2% min
Magnesium	Balance

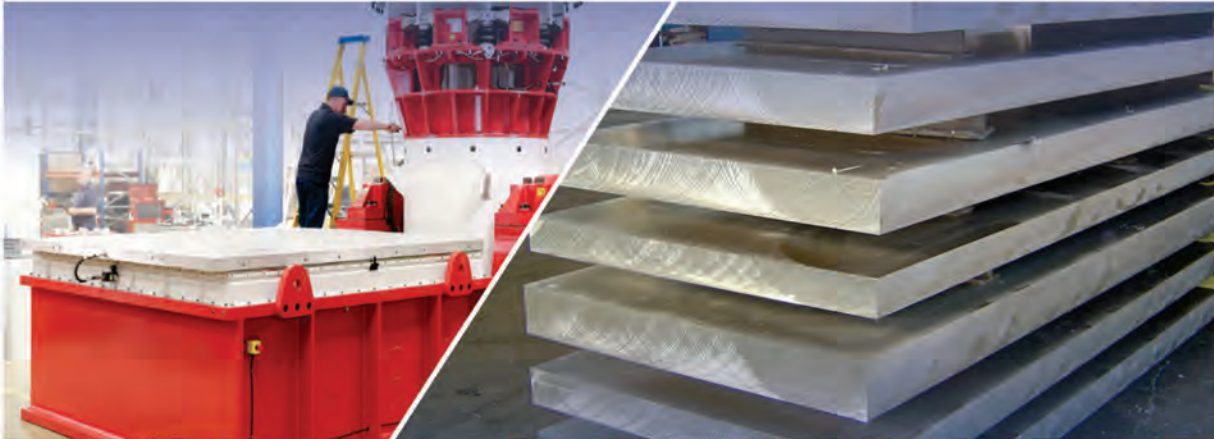
PHYSICAL PROPERTIES

Specific gravity	1.83
Coefficient of thermal expansion	$2.56 \times 10^{-6} K^{-1}$
Specific heat capacity	$993 J kg^{-1} K^{-1}$
Thermal conductivity	$57.6 W m^{-1} K^{-1}$
Electrical resistivity	$148 \mu\Omega m$
Modulus of elasticity	44 Gpa
Poissons ratio	0.295
Melting range	540°C - 640°C

Elektron 43 meets these specifications: AMS4371 Rev. B

Domestically Made / DFARS Compliant

MAGNESIUM PLATE FOR VIBRATION TEST FIXTURES



Magnesium Plate Benefits

- Best damping capacity of any metal
- Lightweight material accommodates heavier loads
- Allows for higher resonant frequencies over aluminum
- Energy savings

Vibration Testing

A key aspect of vibration testing is the machine table and the fixture that supports the component. Both need to be stiff, strong, lightweight and have good damping characteristic to reduce resonance. Magnesium AZ31B-Tool Plate (TP) is an ideal material for these due to its combined physical and mechanical properties.

DAMPING CAPACITY OF MAGNESIUM

Damping capacity is a measure of a material's ability to dissipate elastic strain energy during mechanical vibration or wave propagation. When ranked according to damping capacity, materials may be roughly categorized as either high or low damping. Low damping materials may be utilized in musical instruments where sustained mechanical vibration and acoustic wave propagation is desired. Conversely, high damping materials are valuable in suppressing vibration for the control of noise and for the stability of sensitive systems and instruments.

Properties of Magnesium Alloys AZ31B- Tool Plate

AZ31B-TP has a density of 0.064 lbs/inch³ (1.78g/cm³) which is 30% lower than aluminum alloys. AZ31B-TP is suitable for vibration fixtures and with improved damping capacity has a yield strength of 10Ksi, ultimate tensile strength of 30Ksi, elongation of 9% and a Young's Modulus of 40GPa.

The low density and high damping capacity make AZ31B-TP the material of choice for vibration test fixtures. Fixtures fabricated from AZ31B-TP exhibit higher resonant frequencies relative to equivalent aluminium structures. This allows testing to be carried out at higher frequencies and shorter test times, reducing testing costs. The low density of the tooling plate leads to fixtures with lower weight. This has several benefits. Vibration test machines are limited to a maximum force that they can exert. As $F=ma$ and high acceleration enables higher frequencies within a defined displacement, the reduced mass of a magnesium fixture increases the overall envelope of operation of any given vibration test bed. This allows multiple parts to be run in the same test, greatly reducing the overall cost.

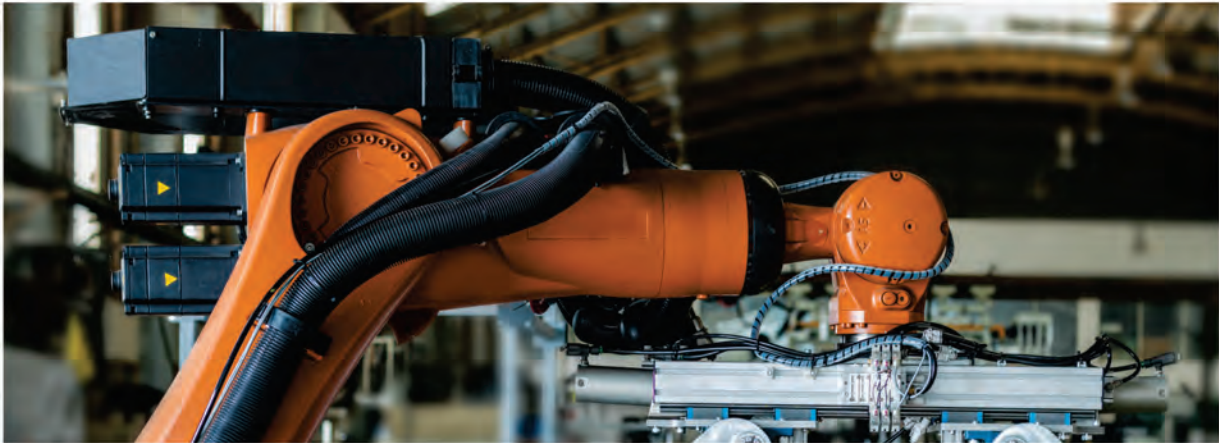
AZ31B-TP is weldable, allowing for the fabrication of complex fixtures.

SPECIFIC DAMPING CAPACITY

AA6061-T6, Zn, Ti	1.50%
Cast irons, Ni alloys	2.50%
Pure Al, Cu	3.50%
Steel	4%
Mg Alloy- AZ31B-F	10%



END-OF-ARM TOOLING (EOAT) FOR INDUSTRIAL ROBOTICS



End of Arm Tooling is crucial to the intricacies of robotic automation. Our magnesium alloys are ideal for this application. Magnesium's lightweight structure improves the speed and performance of the tooling over contemporary alternatives, like aluminum or steel, while achieving a 33% reduction in weight.

The advantages of using magnesium for this application ensures:

- Lowers overall energy cost
- Improves collaborative safety
- Increases speed of automation
- Can receive a larger payload
- Provides excellent vibration dampening
- Can resist wear and tear, reducing maintenance costs”



Mechanical properties of magnesium plate are on par with most typically aluminum grades so little EOAT redesign is needed. Contact Luxfer Magnesium Rolled Products to discuss your Industrial Robotic application and how lightweighting with magnesium can help you win end user business with improved EOAT performance.

GEOLOGICAL SURVEY CALIBRATION BLOCKS



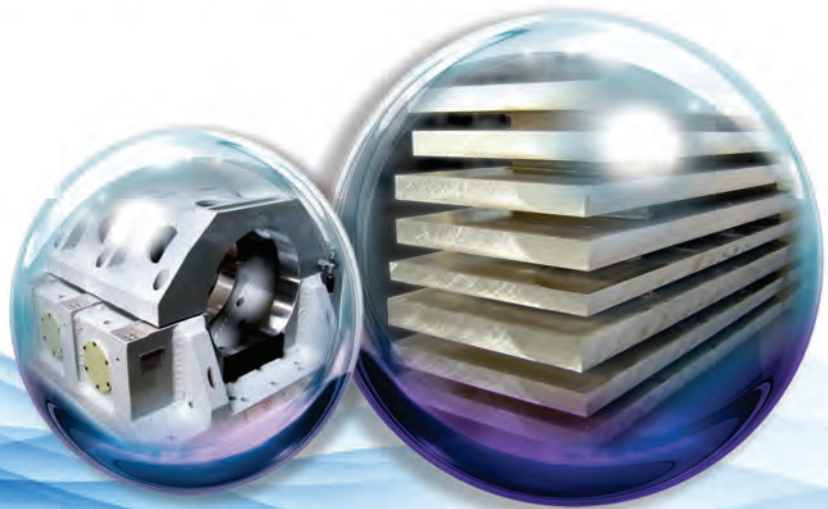
Luxfer Magnesium Rolled Products is the world leader in the development and supply of highly functional magnesium alloys. Our AZ31B Calibration Blocks have been supplied to the Oil and Gas Industry since density logging was developed in the 1950's. Paired with matching aluminum blocks, Magnesium Calibration Blocks are used to calibrate borehole logging tools that measure density based on specific gamma-ray scattering.

Product Forms

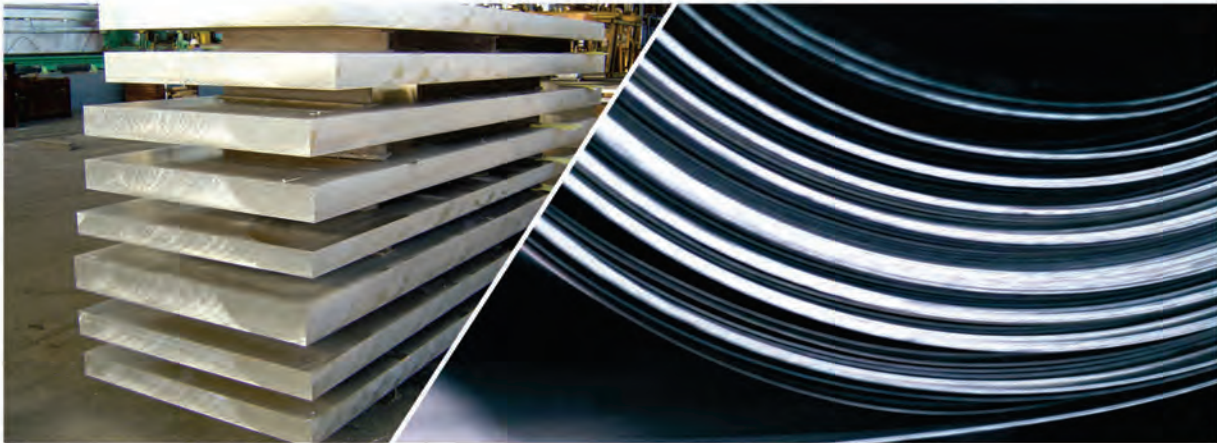
- Cast slab raw material
- Fully machined and coated to customer drawing and specifications

Applications

- Gamma Ray Logging
- Nuclear Logging



MACHINING AND HOUSEKEEPING



GOOD HOUSEKEEPING

When machining magnesium, good housekeeping in the workshop is very important. Chips should not be allowed to accumulate on or inside equipment being used. Accumulation of chips will increase the risk of a larger fire if one was to start. The same goes for chip accumulation on the floor surrounding the machine. Machines should be kept in good working order. Turnings and chips should be stored in steel drums for timely disposal.

LUBRICANT REMOVAL

Ideally, fluid and chips should be separated as soon as possible after machining. Use of a centrifuge, hydroclone, compaction or briquetting machine will help reduce the danger associated with the storage and handling of wet magnesium chips.

SEGREGATION

It is important to segregate chips. Magnesium chips, rasping, and turning should never be mixed with chips of other types of material. Segregation of chips is crucial if any value is to be retained from recycling.

CHIP STORAGE

Chips should never be stored in sacks. Examples of suitable storage equipment are type 1A2 UN approved steel drums with removable lids.

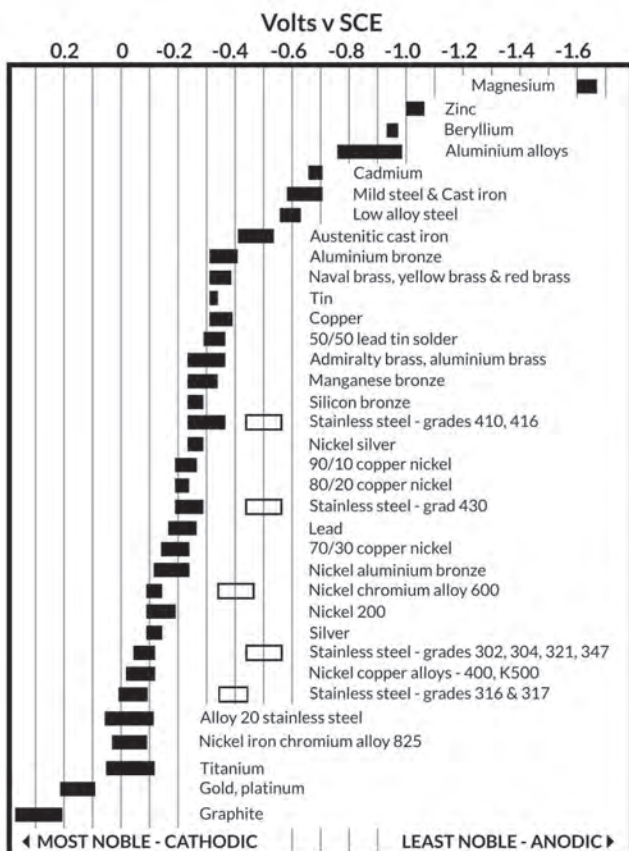
- Wet/oily chips- These should be placed in covered but well ventilated non-combustible containers such as UN approved steel drums. Vents should allow hydrogen gas to escape and reduce the chance of buildup of pressure. The containers must be clearly labeled and stored in a remote location away from sources of ignition. Drums should not be stacked. The area must be well ventilated in order to avoid the buildup of hydrogen gas. Covered outdoor storage is preferred.
- Dry chips- These should be placed in dry, tightly closed, non-combustible containers such as UN approved steel drums. Safely stored, kept dry and clearly labeled. Storage should be in a dry atmosphere and in isolation from flammable materials. Chips covered in mineral oil can be stored the same way as dry chips.



ELECTROCHEMICAL BATTERY STRIPS



Seawater magnesium batteries are a type of primary (non-rechargeable) electrochemical battery featuring a magnesium anode and a noble cathode wetted by a common seawater electrolyte. Seawater magnesium batteries are ideal for use in defense, maritime, and emergency response applications due to their low cost, low weight, critical availability, relative safety, and environmental friendliness over alternative options, such as Lithium-base batteries. Seawater batteries pose a large advantage over contemporary alternatives by eliminating the need to make, transport, store, or dispose of a traditional electrolyte, and by allowing these battery systems to be stored in a dry state, reducing their weight and volume and greatly increasing their storage life.



Magnesium is an ideal choice for anodes due to its highly anodic state (as shown in the chart to the left). The greater the distance between the anode and its cathode (such as graphite or silver, in this case), the greater the theoretic achievable voltage between the pair. Magnesium also presents a high gravimetric and volumetric charge density (which allows for the storage of large currents in small masses and volumes).

Further, magnesium does not naturally form dendrites and does not require the complicated intercalation process (an atom-substrate layering process) to prevent it from creating dangerous short-forming bridges that Lithium requires. Magnesium can be used in as-cast and as-rolled states with minimal processing.

Distribution Network across the globe.



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ROLLED PRODUCTS

For more information visit: www.luxferga.com

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