Magnesium Overview

Magnesium, the world's lightest structural metal with a specific gr vity of 1.74 (.063 lb./cu. in.), occurs widespread in nature in the form of various compounds. The principal ores of magnesium are dolomite, magnesite, and carnallite — magnesium also exists in nature as the chloride in seawater, underground natural brines, and salt deposits. For engineering applications, magnesium is usually alloyed with one or more elements which include aluminum, manganese, rare earth metals, lithium, zinc, and zirconium. The resultant alloys have very high strength-to-weight ratios.

While its light weight is magnesium's best-known characteristic — aluminum weighs 1 1/2 times more, iron and steel weigh 4 times more, copper weighs 5 times more — there are also other desirable properties. Magnesium's excellent machinability makes it economical in parts where weight saving may not be of primary importance, but where much costly machining is required. Such parts, when made of magnesium, can be machined at higher speeds with fewer cuts and with greater economies than are possible with most other metals.

Magnesium can be cast and fabricated by practically every method known to the metal worker. It is cast in sand or permanent molds to obtain light weight castings with good strength, rigidity, and resistance to impact or shock loading. Magnesium sand and permanent mold castings are heat treatable to further improve properties.

The die casting process is likewise applicable to magnesium and this method of casting should always be considered when the quantities desired are in the range that indicates its use. Both hot and cold chamber processes are usable. The metal can also be cast by some of the less common methods including plaster mold, centrifugal, shell molding, and investment processes. Magnesium is rolled into sheet and plate; and can be extruded into rods, bars, tubing and an almost endless variety of structural and special shapes. Sheet and extrusions are very easily formed using techniques that have been developed especially for magnesium. Stamping, deep and shallow drawing, blanking, coining, spinning, and impact extrusion are just a few of the production forming operations regularly used on magnesium and which indicate the metal's adaptability to a large variety of metal working procedures.

Magnesium parts can be joined by any of the common methods. Arc and electric resistance welding, adhesive bonding, and riveting are in daily production use. Brazing and gas welding, although not as frequently used as the other methods, are also suitable ways of joining magnesium.

Symbol	Mg
atomic number	12
atomic weight	24.32
atomic volume cu cm gram/atom	14.0
crystal structure	close-packed hexagonal
lattice parameters	a = 3.203 °A c = 5.199 °A
axial ratio (c a)	1.624
electron arrangement in free atoms	(2) (8) 2
mass numbers of the isotopes	24, 25, 26
relative frequency of the isotopes	77, 11.5, 11.1

Electrical

Temperature °F (°C)	Electrical Resistivity ohms/circular mil-foot (microhm-centimeters)
68 (20)	26.8 (4.46)
572 (300)	57.0 (9.5)
1112 (600)	102.0 (17.0)
1202 (650 liquid)	174.0 (28.0)
1652 (900)	28.0

Temperature coefficient at 68°F (20°) microhm cm/°C:	0.017
Electrical conductivity at 68°F (20°C)	
Mass, percent annealed copper (standard):	198.0
Volume, percent annealed copper (standard):	38.6

Density

Temperature °F (°C)	Density lb/cu ft. (g/cu cm)
68 (20)	109 (1.74)
1202 (650 solid)	103 (1.65)
1202 (650 liquid)	98 (1.58)

Temperature coefficient at 68°F (20°) microhm cm/°C:	0.017
Volume Contraction - 650° liquid to 650° solid	4.2%
Linear Contraction - 650° liquid to 70° solid	1.8%

Thermal

	°F (°C)
Melting Point	1202 (650)
Boiling Point	2030 ± 20 (1110 ± 10)
Critical Temperature (calculated)	3393 (1867)
Flame Temperature (theoretical)	5100 (2820)

Coefficient of Expansio

Temperature Range °F (°C)	Electrical Resistivity Inches/Inch/Degree (mm/mm/Degree)
68-212 (20-100)	0.0000145 (0.0000261)
68-392 (20-200)	0.0000150 (0.0000271)
68-572 (20-300)	0.0000156 (0.0000280)
68-752 (20-400)	0.0000161 (0.0000290)
68-932 (20-500)	0.0000166 (0.0000299)

Specific heat in Btu/lb °F (Cal/gm/°) at

68°F (20°C)	0.245
572°F (300°C)	0.275
1202°F (650°C) (solid)	0.325
1202°F (650°C) (liquid)	0.316

Thermal conductivity at 68°F (20°C)

Btu/in/ft²/°F/hr	1070
cal/cm/cm²/°C/sec	0.37

Thermal diffusivity at 68°F (20°C)

in²/sec	0.135
cm²/sec	0.87

Heat of combustion

Btu/lb/mol	262,000
cal/gram mol	145,000

Latent heat of fusion

Btu/lb	158.8 ± 2
cal/gram	82 ± 2

Latent heat of vaporization

Btu/lb	2270 ± 50
cal/gram	1260 ± 30

Our Products

Our Magnesium extrusions and castings are available in a variety of standard alloys and forms as well as many special shapes and alloys tailored to your needs.

Extruded Form	AZCOML	AZ31B	AZ61A	AZ80A	ZK40A-T5	ZK60A	WE43-T5
Rod, Bar, Solid Shapes	X	X	X	X	X	X	X
Structural Shapes	X	X	X	X	X	X	X
Wire		X	X				
Tube	X	X	X		X	X	X
Hollow Shapes	X	X	X		X	X	X
Semi-Hollow Shapes	X	X	X		X	X	X

Our Alloys

Our magnesium extrusions and castings are offered in a variety of standard alloys and forms as well as many special shapes tailored to customer's specific equirements.

Composition

Alloy	Mg	Al	Ca	Cu	Fe	Li	Mn	Nd	Ni	Rare Earths	Si	Y	Zr	Zn
AZCOML	Balance	2.0-3.6	0.04max	0.1	0.005		0.15min		0.03		0.1			0.3-1.5
AZ31B	Balance	2.5-3.5	0.04	0.05	0.005		0.2-1.0		0.005		0.1			0.6-1.4
AZ61A	Balance	5.8-7.2		0.05	0.005		0.15-0.5		0.005		0.1			0.4-1.5
AZ80A	Balance	7.8-9.2		0.05	0.005		0.12-0.5		0.005		0.1			0.2-0.8
ZK40A-T5	Balance												0.45min	2.5-3.2
ZK60A-T5	Balance												0.45 min	4.8-6.2
WE43-T5	Balance			0.02	0.005		0.03	2.0-2.5	0.002	0.3-1		3.7-4.3	0.2-1	0.06
AZ-91 (cast)	Balance	8.3-9.7		0.03	0.005		0.15-0.5		0.002		0.1			0.35-1

Mechanical Properties

(Typical- solid shapes)	AZCOML	AZ31B	AZ61A	AZ80A	ZK40A-T5	ZK60A-T5	WE43-T5
Yield Strength (ksi)	27	28	31	38	35	44	28
Tensile Strength (ksi)	37	38	45	50	51	53	44
Elongation (%)	15	14	15	6	11	11	6
Shear Strength (ksi)	-	19	22	24	-	26	-
Bearing Yield Strength (ksi)	-	33	42	53	-	59	-
Bearing Ultimate Strength (ksi)	-	56	68	60	-	79	-