Magnesium

oscso

posco

Magnesium

Dream of Material

Toward the world's first class

POSCO strives to achieve the goal to become a global material supplier not settling only for iron and steel business. For this, POSCO is concentrating its capabilities on the development of high strength, super light and new future materials. It produces magnesium and titanium which are receiving attention as super light materials, and makes its efforts on the development of the technology to extract lithium for secondary battery from salt water as well as of materials such as rare earth elements. Also, POSCO and its affiliates are promoting high value added carbon material business and so on, for example, by starting construction of a plant for anode materials for secondary batteries. Through such positive efforts POSCO will become equipped with the capabilities as a producer specialized in general materials.

posco Magnesium Smelting

Magnesium, among commercial metals, is the lightest metal of which demand is gradually increasing. It is the key material to realize weight reduction for the enhancement of energy efficiency, becoming an important resource for the future growth of automobile, IT, mobile and machine parts. POSCO has started producing magnesium ingots, utilizing domestic natural resources and POSCO's proprietary technologies. We promise POSCO will take the initiative in developing global material industry.

History of Magnesium Smelting Business

2009.11
Concluded MOU with Gangreung City of Gangwon Province on cooperation for POSCO Magnesium Smelting Business.

2010.4
POSCO BOD(Board of Directors) approved the first-stage business.

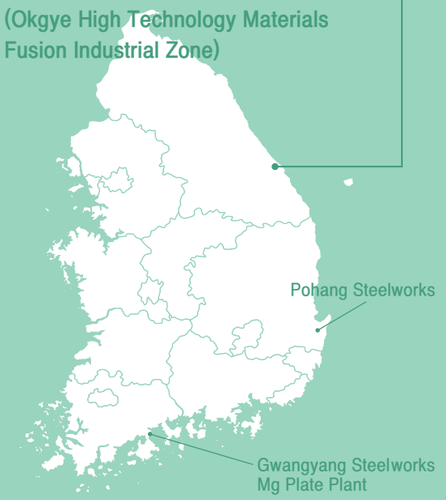
2010.5
Held a presentation for residents on Industrial Complex Development Plan.

2011.6
Held the groundbreaking ceremony for Magnesium Smelting Plant (first stage).

2012.8
Completed construction of the Magnesium Smelting Plant.

2012.11
Started production of magnesium ingot.

POSCO Mg Smelting Plant
(Okgye High Technology Materials Fusion Industrial Zone)



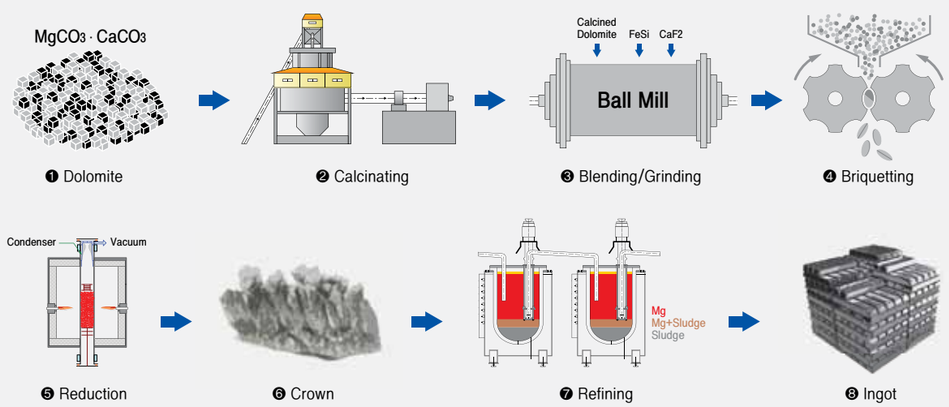
- Location : Okgye-myeon, Gangneung, Gangwaon province
- Site : 462,000m²
- Production capacity : 10,000 ton/year (First Stage)
  Planned to be expanded to 100,000 ton/year (~2018)

▲ POSCO Magnesium Smelting Plant

Excellence of Mg Alloy

Smelting Process

The world best quality magnesium ingot is produced with the dolomites from Gangwon Province as the main raw material and with the capability and experience of POSCO's iron and steel making in the steelworks.



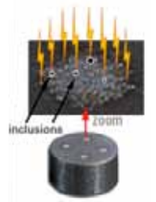
Product : Magnesium Ingot

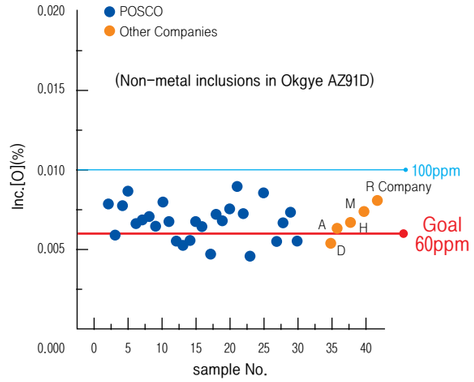
Alloy	Composition(%)	YS(MPa)	TS(MPa)	EL(%)
AZ91D	Al : 9.0 / Zn : 0.5 / Mn : 0.3	160	230	3
AM50A	Al : 5.0 / Mn : 0.5	125	210	10
AM60B	Al : 6.0 / Mn : 0.5	130	220	8
AZ31B	Al : 3.0 / Zn : 1.0 / Mn : 0.3	140	230	10
AZ61A	Al : 6.0 / Zn : 1.0	150	260	6

* POSCO magnesium alloys satisfy ASTM specification.
* Pure magnesium contains 99.9 % of magnesium or higher, and satisfies the specifications such as KS, JIS, GBT, ASTM and ISO.

Quality Level

POSCO measures and evaluates non-metal inclusions using an OES (Optical Emission Spectroscopy).





▲ Contents of non-metal inclusions and oxides in the alloy

Criteria of Non-metal Inclusion control

- POSCO is managing 100 ppm or lower oxides in ingots.
- POSCO is targeting 60 ppm, which is equivalent to or lower than the levels of competitors.

Quality Certification

Since it started mass production in Nov. 2012, POSCO Magnesium Smelting Plant has been certified as follows.

- **ISO certification :** POSCO has acquired ISO9001 in May 2012.
- **RoHS certification :** POSCO complies with the RoHS (Directive on Restriction of the use of certain Hazardous Substances in electrical and electronic equipment) and renews the certificate every year.

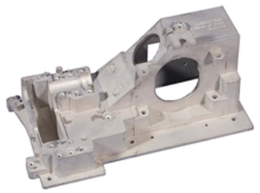
▲ ISO9001 Certificate

▲ RoHS Certificate

IT/Mobile Parts

The market for electronic applications expects to grow 30 % or higher every year for smart phones and tablet devices which require the light weight, fire retardancy and high fluidity of molten magnesium.

▲ Mobile Phone Inner Bracket



▲ Beam Projector Part

▲ Laptop PC Bottom Panel

Automotive Parts

The automotive parts market, which needs the light weight, thermal resistance and high strength of magnesium, is expected to steadily grow thanks to the necessity for environment-friendly fuel economy and increase in the demand for electric/hybrid vehicles.

▼ Steering Wheel Core

59% Weicht Reduction
(Al : 1,400g → Mg : 580g)
AM50A

▼ Head Lamp Unit

36% Weight Reduction
(Al : 350g → Mg : 225g)
AZ91D

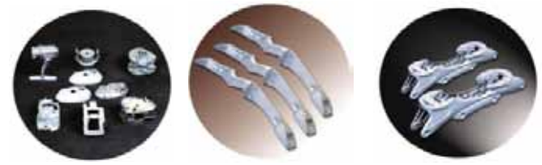
▼ Rear Console Bracket

Enhanced Strength, Light Weight
(Plastic → Mg : 480g)
AZ91D

Other Parts

Magnesium material is newly applied to a variety of fields by using extrusion, rolling and thixo-molding besides die casting.

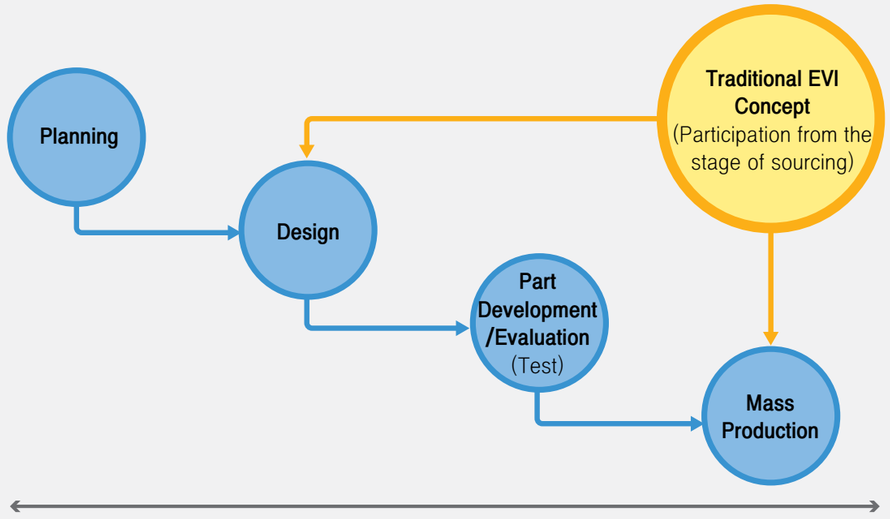
▲ Defense and Aerospace Parts



▲ Sports Leisure Goods

POSCO EVI (Early Vendor Involvement) Activity

This is an advanced technical support and marketing activity in which POSCO jointly develops new parts from the planning stage of auto parts/electronic products to propose new materials and supports forming and design technologies.



POSCO EVI Activity

- Engineering cooperation from the stage of product planning (Establishment of cooperation system between the OEM and the part manufacturer)
- Selection and development of new materials for each part (Development of future technology)
- Troubleshooting during production period

posco Magnesium Flat Products

Magnesium is the 8th abundant material in the earth's crust accounting for the 4th largest amount. The specific gravity of magnesium is 1.74 which is mere 25 % of steel and 70 % of aluminum, and is lightest among metals. Having many superior characteristics such as high specific strength, and shock absorption, magnesium is getting the limelight as an IT mobile material which requires weight reduction and miniaturization at the same time. Since the world is fiercely competing to develop magnesium for the improvement in fuel efficiency through weight reduction of automobile, magnesium is receiving attention as the metal to replace aluminum. Moreover, magnesium can be used for diverse products such as sport, leisure, aerospace and defense parts with superior dimensional stability and machinability.

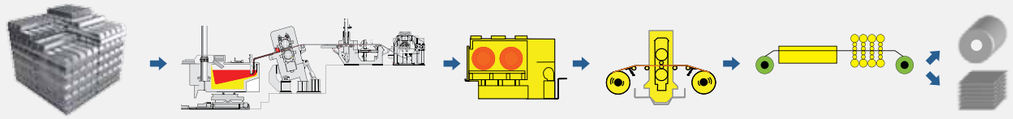
History of Magnesium Flat Products Business

- **2002.7** Commenced business feasibility study
- **2004.2** Started R&D of Magnesium flat products
- **2007.7** Completed construction of Magnesium plate plant (Width: Max. 550mm)
- **2007.10** Initiated the 'Total Solution Provider' activity for development of magnesium market
- **2012.7** Installed the wide width magnesium casting facility (Width: Max. 2,000mm)

▲ POSCO Magnesium Plate Plant

Manufacturing Process

POSCO casts magnesium coils by Strip Caster, and rolls the coils by Reversing Warm Mill.



Chemical Composition and Mechanical Properties of Mg alloys

Alloys	AZ31B	AZ31B-Ca	AZ61A	M1A
CHEMICAL COMPOSITION(wt%)				
Al	2.5 ~ 3.5	2.5 ~ 3.5	5.8 ~ 7.2	Max. 0.2
Zn	0.6 ~ 1.4	0.6 ~ 1.4	0.4 ~ 1.5	Max. 0.002
Mn	0.2 ~ 1.0	0.2 ~ 1.0	0.15 ~ 0.5	1.2 ~ 2.0
Si	Max. 0.1	Max. 0.1	Max. 0.1	Max. 0.1
Fe	Max. 0.005	Max. 0.005	Max. 0.005	Max. 0.005
Ca	Max. 0.04	0.65 ~ 1.0	-	Max. 0.3
Cu	Max. 0.05	Max. 0.05	Max. 0.05	Max. 0.05
Ni	Max. 0.005	Max. 0.005	Max. 0.005	Max. 0.01
MECHANICAL PROPERTIES				
Yield Strength min(MPa)	150	140	170	120
Tensile Strength min(MPa)	221	221	240	210
Elongation min(%)	12(Plate thickness ≥ 0.4) 5(Plate thickness < 0.4)	8(General material), 10(Kitchenware)	6	6
Heat Treatment	'O' Standard(Fully Annealed)			
Remark	'F' (As Rolled) material can be supplied			

AZ31B alloy containing 3 % aluminum and 1 % zinc, AZX311(fire retardant) and AZ61(high strength) are available. M1A(high heat radiation alloy), AZX310(clean surface), AM50A(high fluidity) and AZ91D(high strength) are under development to meet customer demands.

Packing

Magnesium flat product is packed with wrapping paper designed for corrosion prevention. Such packing guarantees the quality of the product for 6 months.

Comparison of the Material Properties with Other Metal Materials

Material	Mg Alloy		Steel		Al Alloy	
	AZ31B (3.0mmT)	AZ61A (3.0mmT)	GA	STS304	5052-H32	6061-T6
Density (g/㎤)	1.78	1.80	7.87	8.0	2.66	2.69
Modulus of Elasticity (GPa)	45	45	210	200	70	69
Tensile Strength(MPa)	266	299	320	505	290	310
Yield Strength(MPa)	165	211	200	215	193	276
Elongation (%)	13	10	28	40	22	12
Thermal Conduct.(W/m · K)	96	70	46	16	138	167
Machinability (%)	100	100	55	-	30	-
Melting Point (°C)	632	620	1,515	1,455	638	646

Thermal Characteristics

• Mechanical Properties by Temperature

	Temp[℃]	Yield Strength [MPa]	Tensile Strength [MPa]	Elongation[%]	비고
AZ31B	150	≤130	≥170	≥35	1.0~2.0t Rolled Product
	200	≤95	≥112	≥38	
	250	≤70	≥73	≥45	
	300	≤48	≥50	≥70	
AZ61	150	≤155	≥195	≥32	2.5~4.0t Rolled Product
	200	≤120	≥143	≥35	
	250	≤90	≥100	≥45	
	300	≤55	≥60	≥70	
AZ31B-Ca	150	≤120	≥145	≥25	3.0~4.0t Rolled Product
	200	≤91	≥112	≥30	
	250	≤66	≥72	≥33	
	300	≤49	≥53	≥45	

• Heat Dissipation Property

Result of measuring thermal diffusivity, specific heat, and density (AZ31B, AZ61 and STS304)

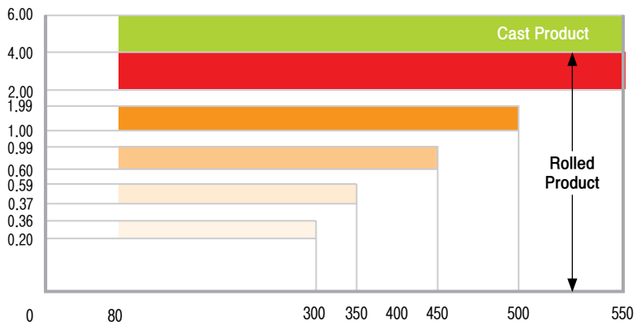
	Specific Heat Capacity [J/g·K]	Thermal Conductivity [W/m·K]	Thermal Diffusivity [10^{-5} m^2/s]
AZ31	1.0	96	5.4
AZ61	1.05	80	4.2
STS304	0.5	16.2	0.4
Al5052	0.88	138	5.9

*Result of the test conducted by Korea Research Institute of Standards and Science.

The heat radiation property of Magnesium is superior to stainless steel by more than 10 times based on thermal diffusivity. Although its heat radiation property is similar to that of aluminum, magnesium is about 30% lighter than aluminum.

Size(based on AZ31B)

Magnesium flat product is produced in the form of coil or sheet. The rolled products are in the thickness between 0.2 and 4.0 mm and to the maximum width of 550 mm. The size of POSCO rolled magnesium is as follows :



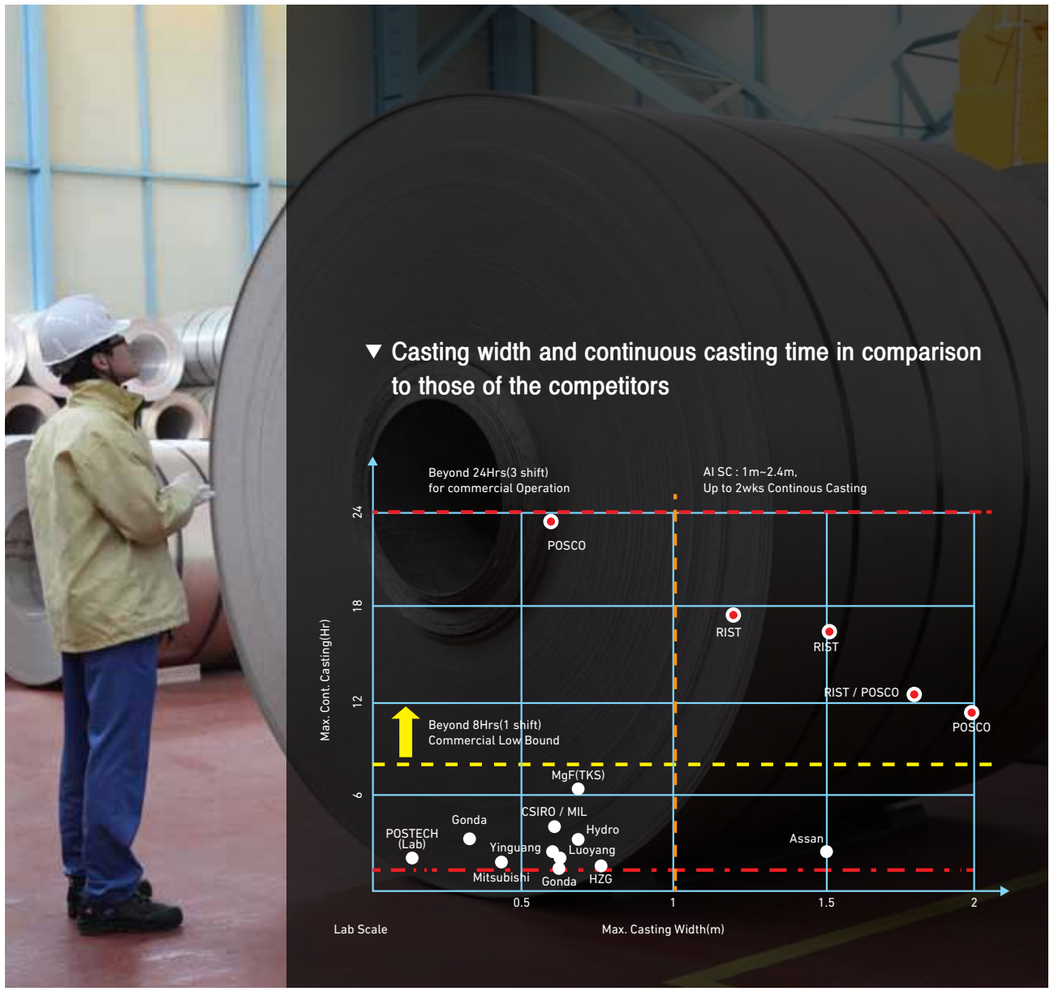
[Based on AZ31B]

(Rolled Product) Thickness, mm	Width, mm
0.20~0.36	300
0.37~0.59	350
0.60~0.99	450
1.00~1.99	500
2.00~4.0	550

*Available length of sheet: 300 ~ 1,000

Wide Plate Business

POSCO has developed the manufacturing technology for 2,000mm wide cast plates in July 2013 by installing Wide Strip Caster which can annually produce 10,000 tons. The thickness is from 5.0 to 6.5mm, and the max. width is 2,000mm.

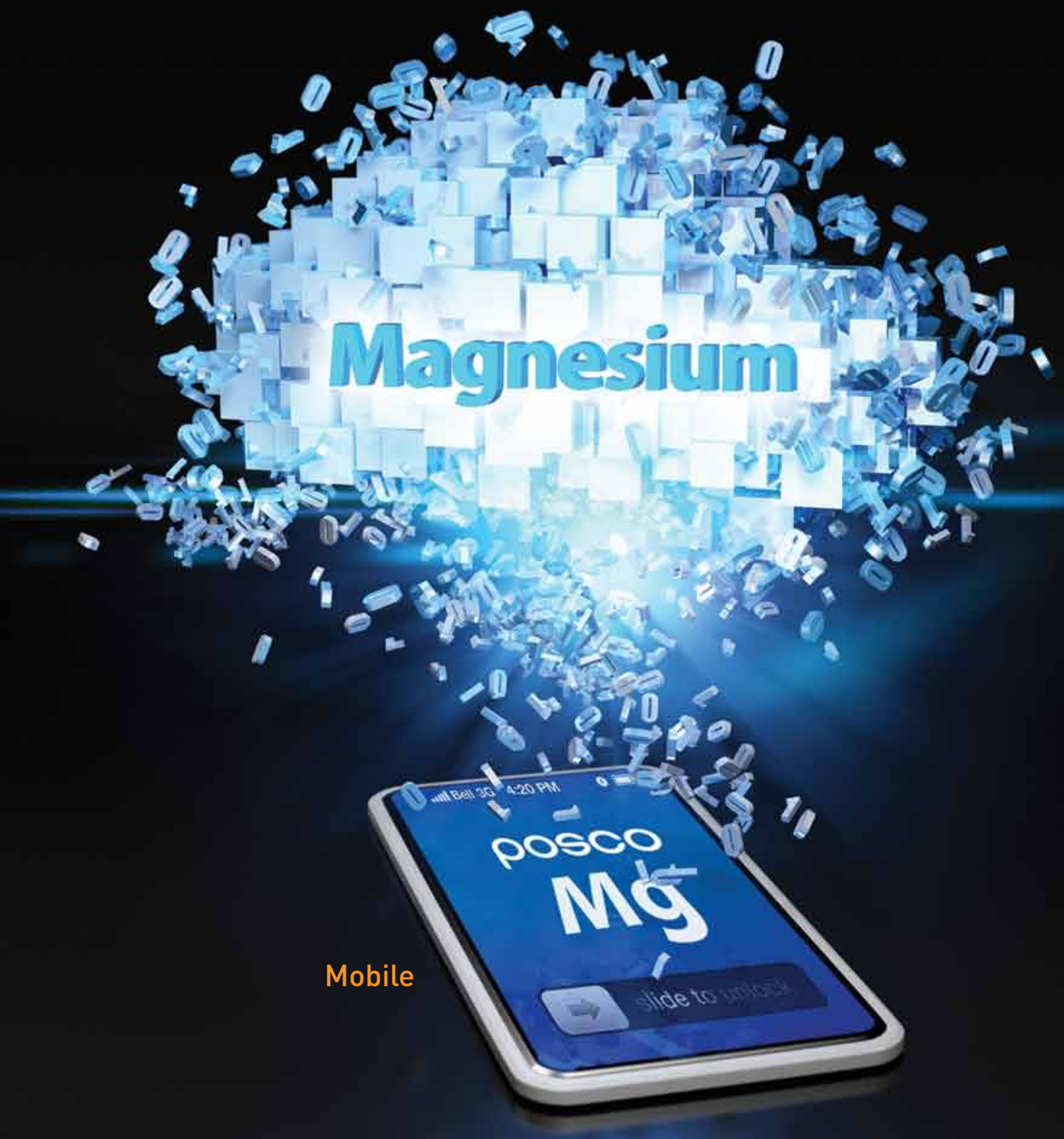


The vision ‘POSCO Magnesium in Every Mobile’ shows that POSCO will apply Magnesium flat product to all the mobile products.

For Electronic Parts

As the high technology applications such as smart phone and laptop computer increase, the demand for magnesium is dramtically growing.

- As magnesium has superior specific strength, dent resistance, light weight and electromagnetic wave shielding property, it is suitable for parts of IT mobile products.
- Magnesium is the optimal material which can satisfy the emotion of consumers by realizing refined metal texture.



Mobile

Digital Camera

Tablet PC Panel

“POSCO Mg in Every Mobile”

Laptop reinforcement panel

TV

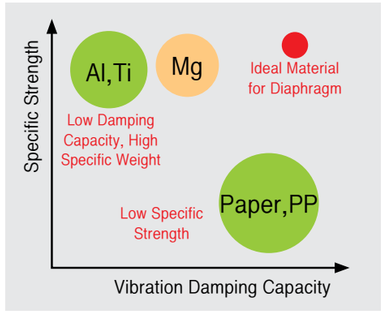
Laptop

For Audio System

What is a speaker diaphragm?
It is a part among speaker components which reproduces sound by vibrating air in the atmosphere.

Superiority of Magnesium Diaphragm

1. With the low density, magnesium diaphragm quickly responses to sound and is able to express minute sound.
2. With the high specific strength, it is able to reproduce a wide range of sound from low to high pitched tone.
3. With the low damping capacity, it reproduces the original sound clearly by decreasing unpleasant resonance noise.




▲ Audio Diaphragm


▲ TV Diaphragm


▲ Automobile Diaphragm


▲ Speaker with a Mg Diaphragm

For Automotive Parts

As the carbon dioxide emission control is getting strict for the purpose of global warming prevention, governments and automotive industry have strived to develep light weight parts in order to increase the fuel efficiency. Korean government is encouraging the development of light weight material by selecting magnesium as one of the 10 biggest *WPM tasks in 2010. POSCO is strengthening collaboration with auto makers and parts manufacturers to develop light weight parts with magnesium.

*WPM : World Premier Materials(10 Key Material Project)


▲ Seat Frame


▲ Hood Assembly


▲ Dash Panel

For Kitchenware

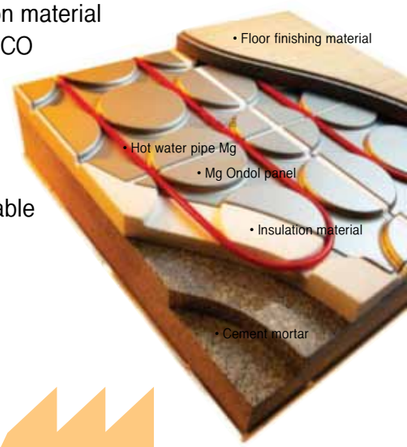
Magnesium is an essential and beneficial mineral to a human body, and has advantages that cooking time can be shortened because it has fast thermal diffusion time in comparison to other materials and the far infrared ray generated by the ceramic coating makes food to evenly cooked, giving it a good taste.

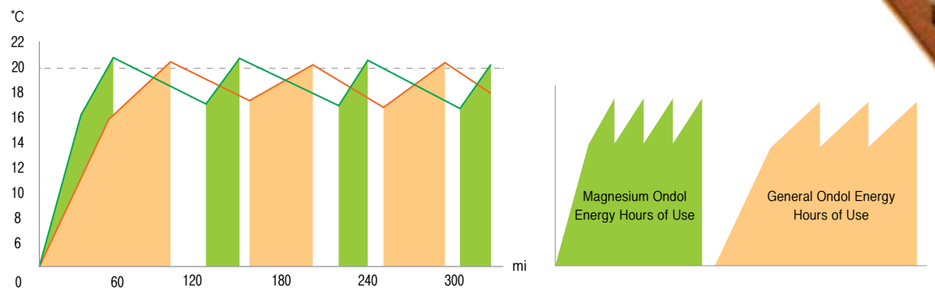

▲ **Mg Frying pan**
POSCO P&S(KC Chemical) etc.


▲ **Mg Barbecue Grill** Mc GREEN/KOREA-Mg

For Construction Materials

Magnesium Ondol panel is a high efficient and highly functional construction material jointly developed by Steel Structure Research Laboratory of RIST and POSCO E&C Technical Research Institute with rolled magnesium. The excellent thermal conductivity of magnesium enables to save a heating cost by enhancing energy efficiency. (The result of the test conducted by Korea Conformity Laboratories shows that heating cost can be saved by 17 %.)
Also, the superior shock absorbing property makes residential life comfortable by reducing inter-floor noise.





For Medical Appliances

The medical/rehabilitation market is continuously growing due to the increase in the aged and obese population, and the related products such as knee brace is getting popular in advanced countries. POSCO has applied various magnesium alloys to knee brace.


▲ Knee Brace

For Defense Products

A sea water battery generates eletricity by a chemical reaction when seawater flows in. POSCO supplies rolled magnesium for the electrode of seawater battery after passing the strict tests.


▲ Seawater Battery

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(892 Daechi-dong, Gangnam-gu, Seoul, Korea)

· **Mg Smelting Plant :** Okgye-myeon, Gangneung-si, Gangwon-do, Korea
(274, Jusu-ri, Okgye-myeon, Gangneung-si, Gangwon-do, Korea)

· **Mg Plate Plant :** 5, Haeryongsandan-2-ro, Haeryong-myeon, Suncheong-si, Jeollanam-do, Korea
(Hodu-ri, Haeryong-myeon, Suncheong-si, Jeollanam-do, Korea)