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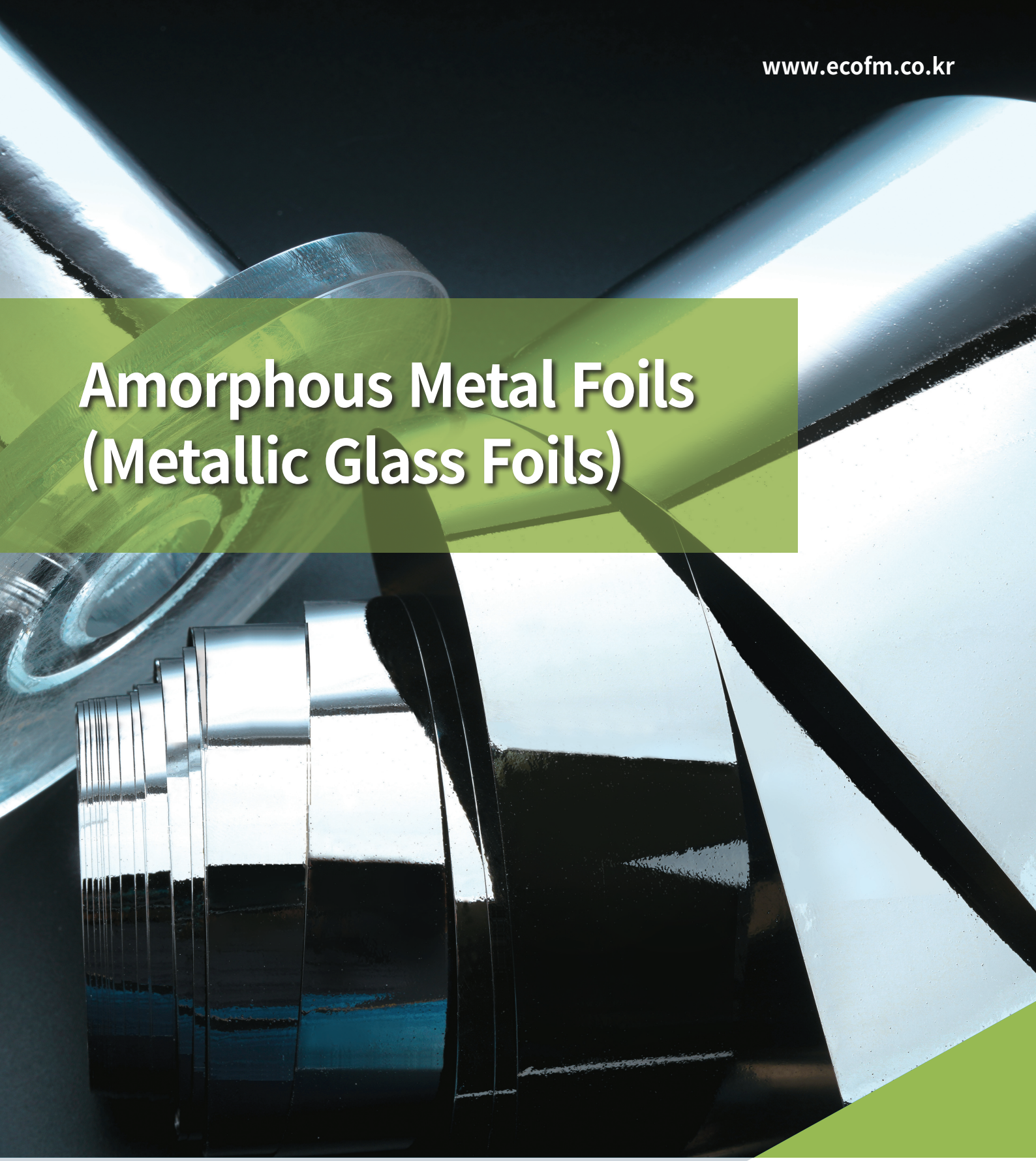
# Amorphous Metal Foils (Metallic Glass Foils)

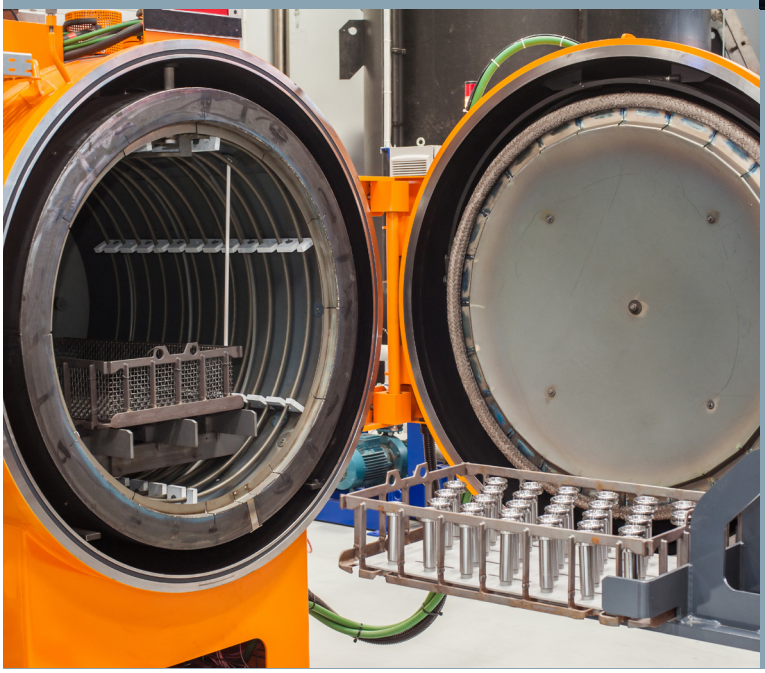


- Vacuum Melt Spinning Technology
- Accurate control for thickness and width
- Customized alloy compositions

ECO FM
functional materials

- **Ultra-Active Brazing Div.**
- **Amorphous Metal Foils Div.**
  (Customized alloy compositions)

ECO FM
*functional materials*



**ECO FM is striving to play a leading role in the realization of a new paradigm and the practice of innovation at the center of change.**

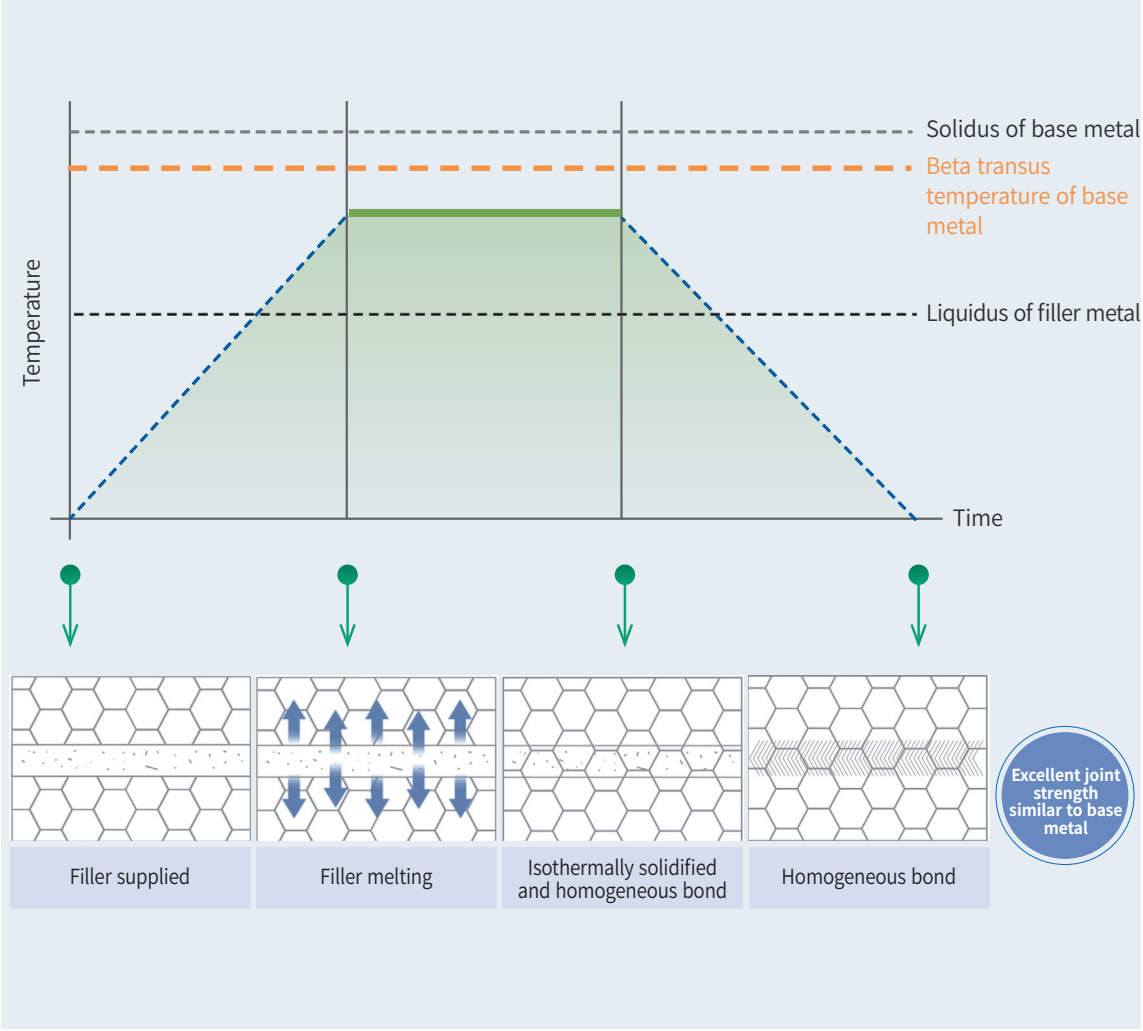
**We will do our best to grow as a global leader in the field of materials through the development of amorphous metal and brazing filler metal, as well as new high-tech materials and environmentally friendly metal sheet manufacturing technology.**

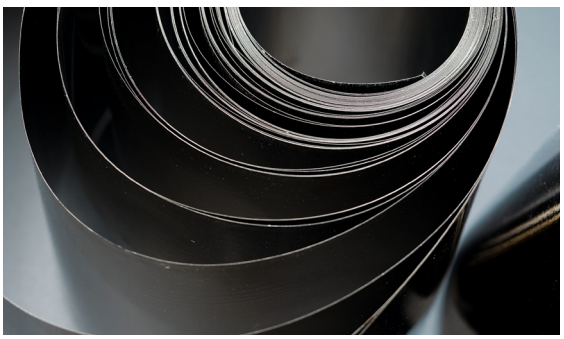
# Ultra-Active Brazing Division

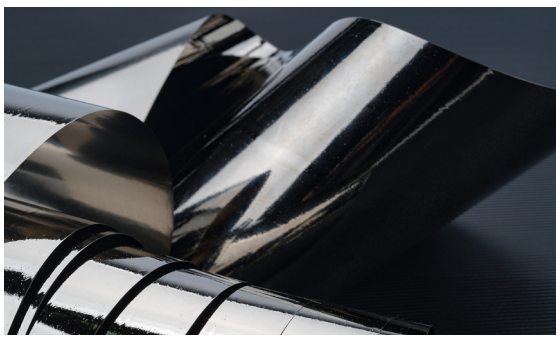
## Technology

### Ultra-Active Brazing

Active brazing is a technique for strong and precise bonding of metal + metal or metal + ceramic at high temperature without damaging the base materials.



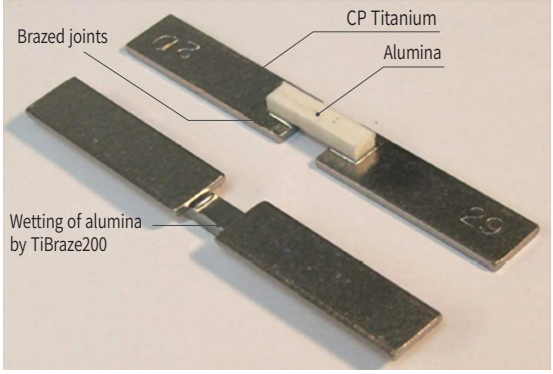


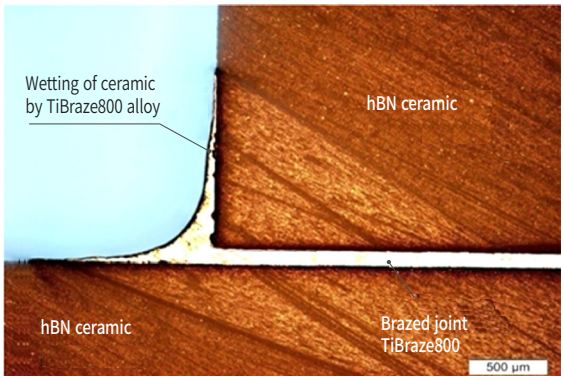
# Ultra-Active Brazing Division

## Technology

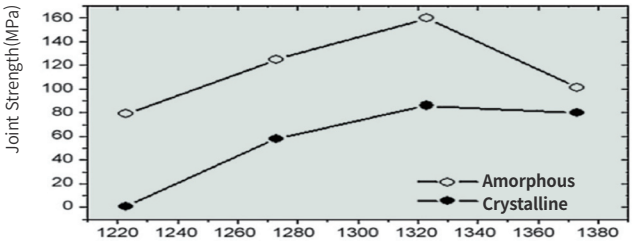
- Joining Metal-to-Metal and Metal-to-Ceramic
- Excellent Wettability and Flowability
- Brazing without Inner Defects
- Much Higher Joint Strength than Crystalline Filler Metals
- Low Coefficient of Thermal Expansion
- No Need for Metallizing and Plating

## Excellent Flowability and Wettability



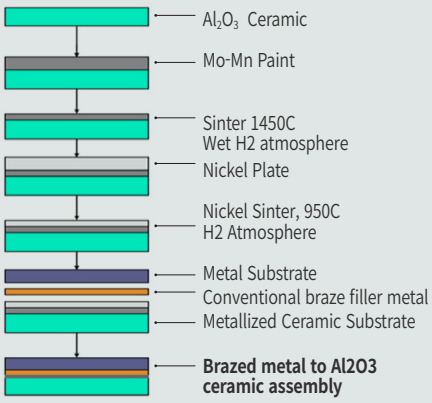

## Excellent Joint Strength



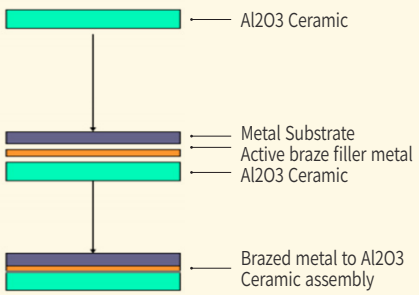

* Comparison of strength of joints brazed with amorphous Ti40 Zr25 Ni15 Cu20 filler and with Ti40 Zr25 Ni15 Cu20 crystalline filler.

## Simple Process

### Mo+Mn / Ni Plating




### Ultra-Active Brazing



# Ultra-Active Brazing Division

## Technology

### Brazing filler metals: Amorphous foil vs. Powder

| Parameters | Amorphous foil | Powder |
|---|---|---|
| The same, uniform thickness of brazing alloy on the whole area of the joint | Always the same and uniform thickness in the joints | Not always the same thickness in the joints |
| The same thickness and quantity of the braze alloy in all layers of the heat exchanger | Always the same thickness in all layers of the heat exchanger every day | Not always the same thickness in layers of the heat exchanger |
| Special equipment and processing to deposit brazing alloy on surfaces to be brazed before assembling heat exchangers | No equipment and processing are needed before assembling | Special equipment and long processing are necessary before assembling |
| Hazardous material | Not hazardous Ecologically clean | Very fine powder is a hazardous material |
| Clean work space of operation | Clean | Fine powder and binder vapors are in the air of work space |
| Stable quality of brazed joints | Always | Not always |
| Stable high strength of brazed joints | Higher strength of brazed joints | Lower strength of brazed joints |
| Specific area covered by brazing filler metal, $m^2$/lb | ~1.56 $m^2$/lb for the foil 50 microns thick | Est. ~1.0 $m^2$/lb for the powder -325 mesh and layer 50 - 60 microns |
| Shelf life of the brazing filler metal | At least 12 years, packaged in plastic bags | 3 years, packaged in aluminum bottles |

# Ultra-Active Brazing Division

## Products

### Ultra-Active Brazing

- Bonded directly to ceramics
- Time and costs savings
- Foil form brazing

- For Metals to Metals and Metals to Ceramics Brazing
- Eliminates process steps when brazing ceramics to metals, allowing metals to be bonded directly to ceramics without metallization/plating the surface prior to brazing
- Time and costs savings
- For any combination of ceramics, metals, carbon, graphite and diamonds
- In its foil form, it can be used for brazing honeycomb and metal seal strips

| Items | Composition (wt.%) | | | | | | Solidus (°C) | Liquidus (°C) | Products |
|---|---|---|---|---|---|---|---|---|---|
| | Ag | Ti | Cu | Ni | Zr | Nb | | | |
| BTi-1 | - | 70 | 15 | 15 | - | - | 910 | 960 | Powder |
| BTi-2 | - | 60 | 15 | 25 | - | - | 901 | 915 | Powder |
| BTi-3 | - | 37.5 | 15 | 10 | 37.5 | - | 821 | 835 | Powder |
| BTi-4 | - | 44 | 16 | 16 | 24 | - | 835 | 849 | Powder |
| BTi-5 | - | 40 | 20 | 20 | 20 | - | 846 | 856 | Foil & Powder |
| AMF-Z3 | - | 17.2 | - | 24 | 58.8 | - | 798 | 809 | Foil & Powder |
| AMF-Z4 | - | 14.2 | 6.8 | 12.6 | 66.4 | - | 774 | 783 | Foil & Powder |
| AMF-Z3Nb | - | 10.3 | - | 19.5 | 63.2 | 7 | 791 | 808 | Foil & Powder |

- Accurate control for thickness and width
- Brazing filler metals for customer's composition

# Ultra-Active Brazing Division

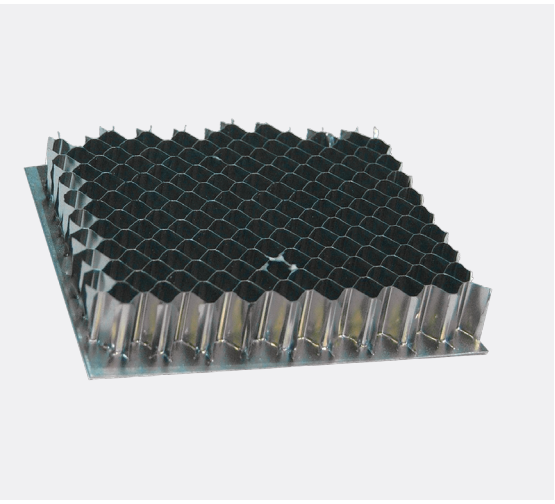
## Business Fields

### Brazing products

- Electrostatic Chuck, Ceramic Substrate, blade, vane
- Titanium Heat Exchanger, honeycomb
- Micro-channel device

Aerospace Parts

Micro-channel Device

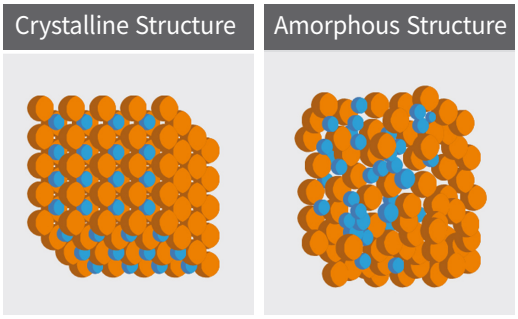


Honeycomb panel
Brazing of thin wall structure

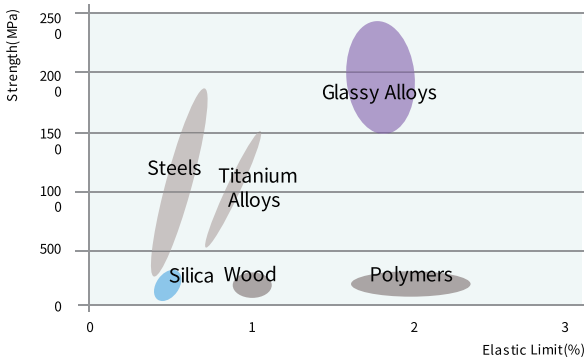
# Amorphous Metal foils Division

## Technology

### Amorphous metals



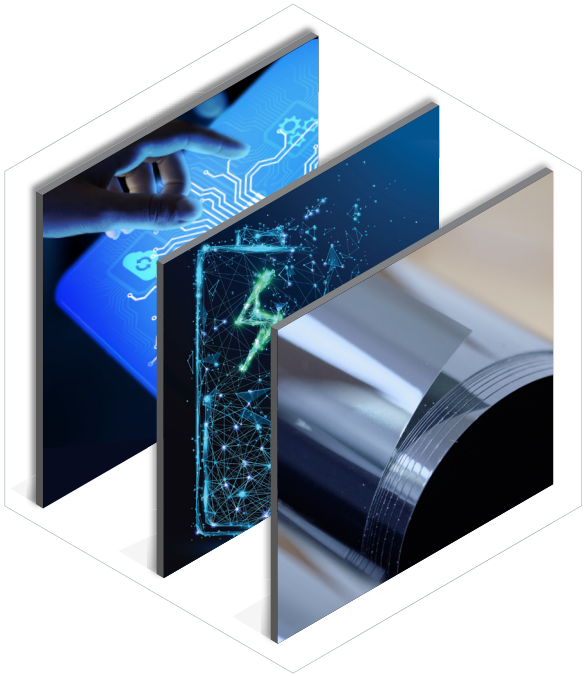

Difference in structure




Typical strengths and elastic limits for various materials. Amorphous Metals are unique.

### Excellent Physical Properties :

- High Strength, High Elasticity
- High Hardness, Superior Wear Resistance
- Superior Corrosion Resistance
- Super plasticity within $T_g$ range (Precise Hot-Forming)
- Excellent Electro-chemical Properties
- Biocompatibility

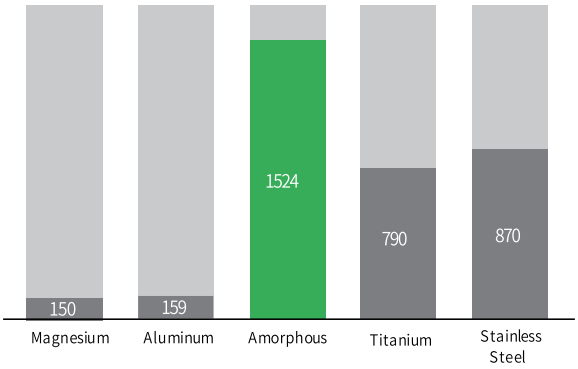


# Amorphous Metal foils Division

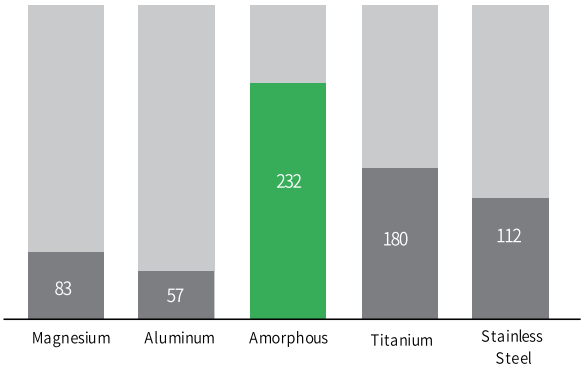
## Technology

### Mechanical Properties of Amorphous metals

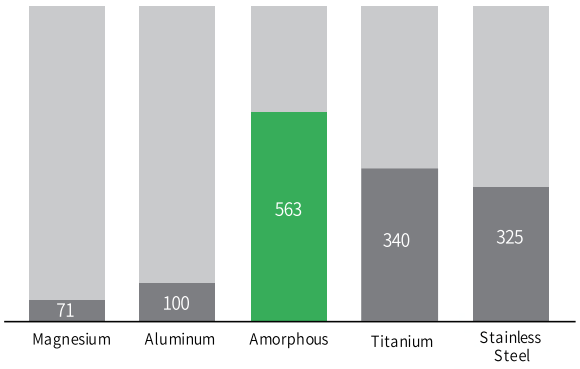
Strength (MPA)



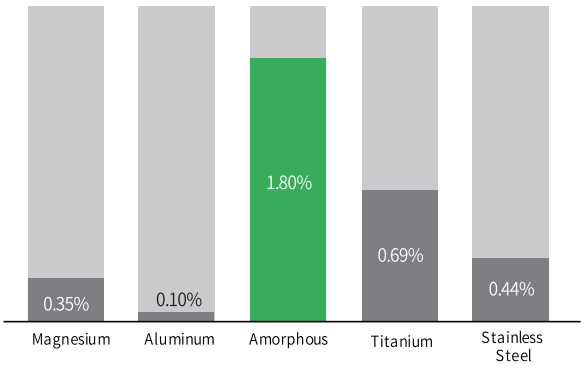

Strength-to-Weight(Mpa.cm$^3$/g)




Hardness (Vickers)

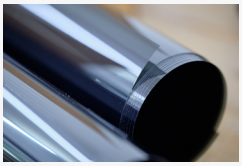



Elasticity(% of Original Shape)



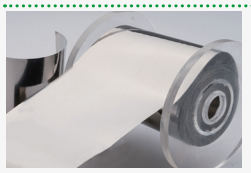

# Amorphous Metal foils Division

## Products



**Alloy Compositions** — Zr-based, Ti-based, Al-based, Cu-based and so on.

**Thickness of the Foils** — 30 μm ~ 200 μm

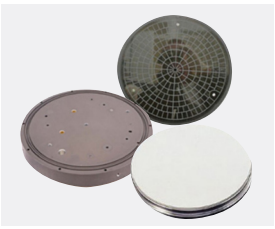


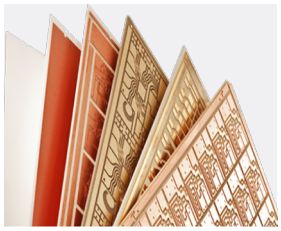
**Width of the Foils** — Max. 125 mm

* Customized alloy compositions

## Business Fields

- Ultra-active Brazing for ceramic-to-metal and metal-to-metal bonding
- Anti-bacterial Applications
- Inner Hinge for flexible Display
- Bullet proof material
- Feedstock for Additive manufacturing
- Membrane for Hydrogen Separation
- Anode Material for Li-ion Batteries
- EV- Motor and EMI Shielding
- Precise Sensors







Please feel free to contact us if you have any requests.

ECO FM
*functional materials*

GYEONGGI-DO

Tel. +82-31-355-1370 Fax. +82-31-355-1371
Http://www.ecofm.co.kr e-mail: yskim@ecofm.co.kr / hgchung@ecofm.co.kr / +82-10-5251-3894
Head Office 1308-10, Gungpyeonghang-ro, Seosin-myeon Hwaseong-si, Gyeonggi-do, Korea 18556