

## Bulk Metallic Glass – The Next Metal

The space race brought us new materials in the last century. This century is all about communications and social networking and it's time for a new revolution of materials: Bulk Metallic Glasses.

### Inside Bulk Metallic Glasses (BMGs)

Metals that are very different from one another can be combined with intense heat and melted together to make a beautiful liquid. When this liquid is cooled rapidly enough, the metal atoms retain the liquid-like random positions from the melt to form a glass (amorphous alloy). You may know that glasses are commonly very hard and very resistant to scratching but did you know when you make a glass using metals, you get one of the strongest materials known!

### Specific Properties

**Strength-to-Weight:** The strength-to-weight ratios of BMGs can be typically twice that of titanium, magnesium, or aluminum.

**Hardness:** BMGs can have a Vickers hardness above 500, which is twice the hardness of most stainless steels and titanium, and at least four times the hardness of aluminum and magnesium.

**Elasticity:** BMGs can be three times more elastic or resilient than practically all crystalline metallic alloys, at a whopping 2% elastic deformation.

### Corrosion and Wear Resistance

Some BMGs are highly resistant to severe environments. Alloys that contain elements such as beryllium or niobium tend to be highly resistant to corrosive environment. In general, the resistance to erosion is outstanding in all of these BMGs.

### Fabrication of BMG Components

Similar to plastics, BMGs can be processed using a hybrid form of injection molding and die casting process resulting in very intricate shapes with high dimensional tolerance and features. Due to this ease of fabrication, post machining and surface modification operations are greatly reduced. BMGs can also be plastically deformed by forging-like operations under controlled atmospheres and temperature.

### What we produce

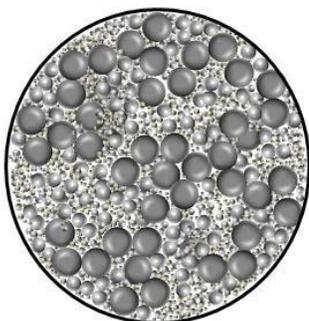
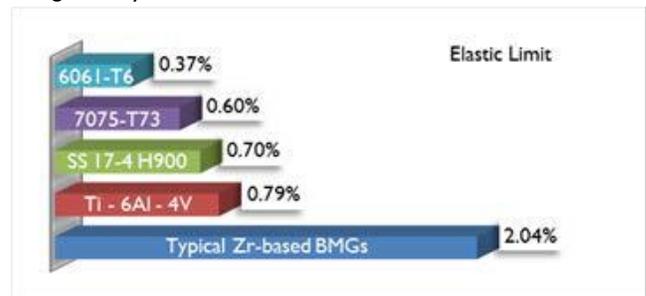
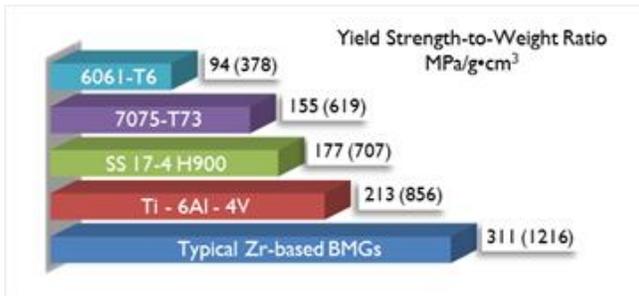
**Vit 1b:** Zr67Cu10.6Ni9.8Ti8.8Be3.8 (wt%)

A robust glass former with proven manufacturability.

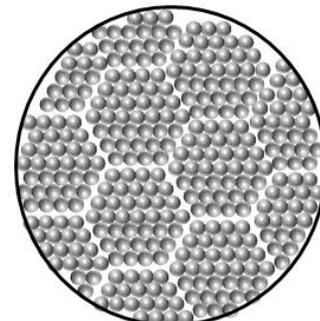
**Vit 105:** Zr65.7Cu15.6Ni11.7Al3.7Ti3.3 (wt%) Good corrosion resistance and manufacturability.

**Vit 601:** Zr62.5Cu31Ni3.2Al3.3 (wt%) A lower cost option to Vit 105.

**Vit 106a:** Zr70Cu13Ni9.9Al3.65Nb3.4 (wt%) The most robust glass forming Zr alloy without Be.



Metallic Glass



Most Metals

#### EUTECTIX LLC

1864 Northwood Dr, Troy, MI 48084

248-293-3200

[www.eutectix.com](http://www.eutectix.com)

[info@eutectix.com](mailto:info@eutectix.com)

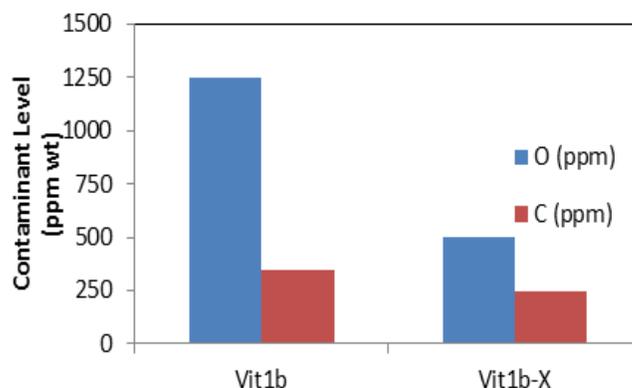
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## Melting and Casting

- Vacuum Induction Melting production of BMG alloys – approximately 5 - 200 kg capacity furnaces
- Ability to cast both crystalline feedstock geometries such as rod, or amorphous plate (~5 mm x 100 mm x 125 mm)
- Strong heritage of a wide range of alloys including zirconium-based alloys, with and without beryllium, and also alloys that contain phosphorus

## BMG Characterization and Analysis

- Counter-gravity set-up for producing a wide range of specimens
- Differential scanning calorimetry
- Compression formability apparatus (constant force or strain rate) in either air or protective atmosphere
- Optical and scanning electron microscopy capabilities
- Hardness and density testing
- Chemical analysis, including (ICP-OES, DCP, LECO (O, N, C, S), and Cu electro-plating



Parameter	Units	Alloys			
		Vit 1b**	Vit 601	Vit 105	Vit 106a
Yield Strength	MPa (ksi)	1800 (261)	1795 (260)	1850 (268)	1800 (261)
Elastic Modulus	GPa (10 <sup>6</sup> psi)	95 (13.8)	91 (13.3)		95 (13.8)
Fracture Toughness	MPa√m (ksi√in)	55 (50.0)	70 (63.7)	75 (68.3)	30 (27.3)
Density	g/cc (lbs./in <sup>3</sup> )	6.0 (0.217)	6.9 (0.249)	6.6 (0.238)	6.7 (.242)
Glass Transition (T <sub>g</sub> )	C (F)	352 (665)	420 (788)	403 (757)	395 (743)
Crystallization (T <sub>x</sub> )	C (F)	466 (871)	495 (923)	469 (876)	499 (930)
Melt Temp (T <sub>m</sub> )	C (F)	644 (1191)	753 (1387)	805 (1481)	837 (1539)

\*\*Vit1b is also sold as Vit1b-X, an alloy with reduced oxygen content.



NOTE: For additional information on safe handling practices or technical data, please contact Eutectix' Product Stewardship at +1.248-293-3200.

Eutectix manufactures high quality amorphous rods