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Opinion

# Research Progress of Be-Al Alloys

**Yao Xie, Junyi Li, Dongxin Wang*, Zhaogang Liu and Yiqun Yang**

State Key Laboratory of Special Rare Metal Materials, Northwest Rare Metal Materials Research Institute Ningxia Co., Ltd., China

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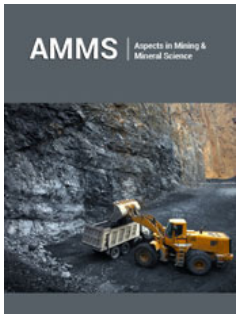


***Corresponding author:** Dongxin Wang, State Key Laboratory of Special Rare Metal Materials, Northwest Rare Metal Materials Research Institute Ningxia Co., Ltd., Shi Zuishan753000, Ningxia, China

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## Opinion

Beryllium (Be, melting point:1287 ℃) has very low density, high strength and stiffness, and high thermal conductivity, this is the main reason that Be is of interest in aerospace, specialized commercial applications and military applications [1]. However, be metal is a brittle material with an elongation of less than 3% at room temperature. It is apparent that an alloy was needed which would closely approach the desirable characteristics of Be (high Young's modulus and low density) but alleviate or eliminate the undesirable ones by using as the second component a very ductile material. Aluminium (Al, Face-centered cubic) is selected as the soft ductile envelope material for the hard Be particles, because good plasticity results from the multiple-slip systems of Al (melting point: 661 ℃), and it has a relatively low density [2]. Be-Al alloy is a kind of light metal [3] and has been developed in the 1960s [2]. Combining the advantages of Be and Al, Be-Al alloys have excellent properties such as low density, high specific stiffness, specific strength, elevated thermal conductivity, and low expansion, the advantages of investment cast Be-Al alloys over other lightweight alloys are obvious, as shown in Table 1. They are widely used in aerospace and weapons under normal manufacturing conditions. Been the temperature reaches (644±1) ℃, the eutectic point of Be-Al binary alloy is located at (2.4±0.5) at.% Be. At this temperature, the solid solubility of Be in Al is only 0.3 at. %, while Al is virtually insoluble in Be, and the solubility between them is extremely limited. Therefore, in previous studies [4-6], it is considered that Be-Al alloy is a kind of composite material with discontinuous granular Be phase reinforcing Al matrix.

**Table 1:** The properties of Be-Al alloy (AlBeCast®910) and other light alloys [7].

| Property | AlBeCast®910 | Aluminum A357-T6 | Titanium 6AL-4V | AlSiC F3A205-T6 |
|---|---|---|---|---|
| Density g/cm$^3$ | 2.17 | 2.69 | 4.43 | 2.69 |
| CTE (25 ℃) ppm/℃ | 14.6 | 21.5 | 9.3 | 16.4 |
| Modulus GPa | 193 | 72 | 110 | 72 |
| Yield Strength, MPa | 165 | 248 | 880 | 165 |
| Ultimate Tensile Strength, MPa | 211 | 317 | 950 | 196 |
| Specific Stiffness, GPa/(g/cm$^3$) | 88.94 | 26.77 | 26.77 | 26.77 |

The main forming techniques of Be-Al alloy include powder metallurgy and precision casting, moreover, plastic processing can also be achieved by extrusion, wrought and rolling [7]. The microstructure of Be-Al alloys prepared by powder metallurgy depends mainly on the shape and size of the original powder. Be-Al alloys produced by precision casting has a smaller grain size and defects such as cracks, porosity, holes, segregation and inclusions are easily avoided. As a result, Be-Al alloys (AlBeMet® AM162 [8] and 62Be/6061Al [9] produced by powder metallurgy have better mechanical properties and those produced by precision casting. The same basic equipment for Al investment casting is used in the casting process of Be-Al alloy, and the only unique features of the Be-Al Cast process are the need for particulate collecting equipment and the use of vacuum casting versus the more traditional

air melt casting process. The specific series of products are AlBeCast® 910(61Be-Al-3Ni) [10], AlBeCast® 920(64Be-Al-1Co) [10], AlBeCast® 930(47Be-Al-4.5Si-2Ag-0.04Sr) [10], Beralcast® 363(65Be-Al-3Ag-1Ge-1Co) [11] and 62Be-Al-0.4Sc alloy [12]. The employees who are exposed to Be (dust) could lead to the more-common chronic Be disease and/or to Be sensitization during the manufacturing of Be alloy [13]. Be-Al alloy is a typical alloy with a high beryllium content. Consequently, toxicity protection of Should be taken into account in the research and production process; however, it should be mentioned that the toxicity of Be and Be-Al alloy has no negative impact on the use of the product.

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