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Al-Be-Sm (Aluminum-Beryllium-Samarium)

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Recently, Odinaev et al. [1996Odi; 2004Odi] determined the phase equilibria of this system in the Al-rich region. [2004Odi] presented six vertical sections and a liquidus projection for Sm-lean alloys.

Binary Systems

The Al-Be phase diagram is of the simple eutectic-type, with the eutectic at 2.7 at.% Al and 644 °C [2006Oka]. The Al-Sm system [2007Del; 1989Gsc] depicts the following intermediate phases are: Sm_3Al_{11} ($D1_3$, Al-deficient Al_4Ba-type tetragonal), $SmAl_3$ ($D0_{19}$, Ni_3Sn-type hexagonal), $SmAl_2$ ($C15$,$MgCu_2$-type cubic), SmAl (ErAl-type orthorhombic) and Sm_2Al ($C23$, Co_2Si-type orthorhombic). In the Be-Sm system, a compound $SmBe_{13}$ ($D2_3$, $NaZn_{13}$-type cubic) is known.

Ternary Phase Equilibria

With starting metals of 99.995% Al, 99.8% Be, and 99.98% Sm, [2004Odi] arc-melted 60 Al-rich alloys under He atm. The phase equilibria were studied with metallography, x-ray powder diffraction, and differential thermal analysis at a heating/cooling rate of 10 °C/min. A ternary phase at the composition $Al_{57}Be_{23}Sm_{20}$ (denoted τ here and D_5 by [2004Odi]) with a melting point of ~1100 °C was reported by [1996Odi] and [2004Odi]. The crystal structure of this phase does not appear to have been determined. The liquidus projection constructed by [2004Odi] for the Al-rich region is redrawn in Fig. 1 to agree with the accepted binary data. The details at the Al corner are shown enlarged. There are several pseudobinary sections in this region: the pseudobinary joins are indicated by thin long-dash-short-dash lines in Fig. 1. The phases of primary crystallization are marked. [2004Odi] listed the compositions and temperatures of the binary invariant reactions and the ternary univariant and invariant reactions. The final solidification in the $SmBe_{13}$-$SmAl_2$-τ and Sm_3Al_{11}-$SmAl_2$-τ regions is through the ternary eutectic reactions E_1 and E_2. The four-phase invariant reactions close to the Al corner are U-type transition reactions and, accordingly, U_1, U_2, and U_3 symbols are used in place of P_1, P_2, and P_3 used by [2004Odi]. The numbering sequence of reactions such as e_2, e_3, etc. given by [2004Odi] is retained for easy comparison.

Using their DTA data, [2004Odi] constructed six vertical sections along the Al-τ, Al-$SmBe_{13}$, τ-$SmBe_{13}$, $SmAl_2$-$SmBe_{13}$, τ-$SmAl_2$, and τ-Sm_3Al_{11} joins. The sections along Al-τ and Al-$SmBe_{13}$ joins are of the simple peritectic type and are shown

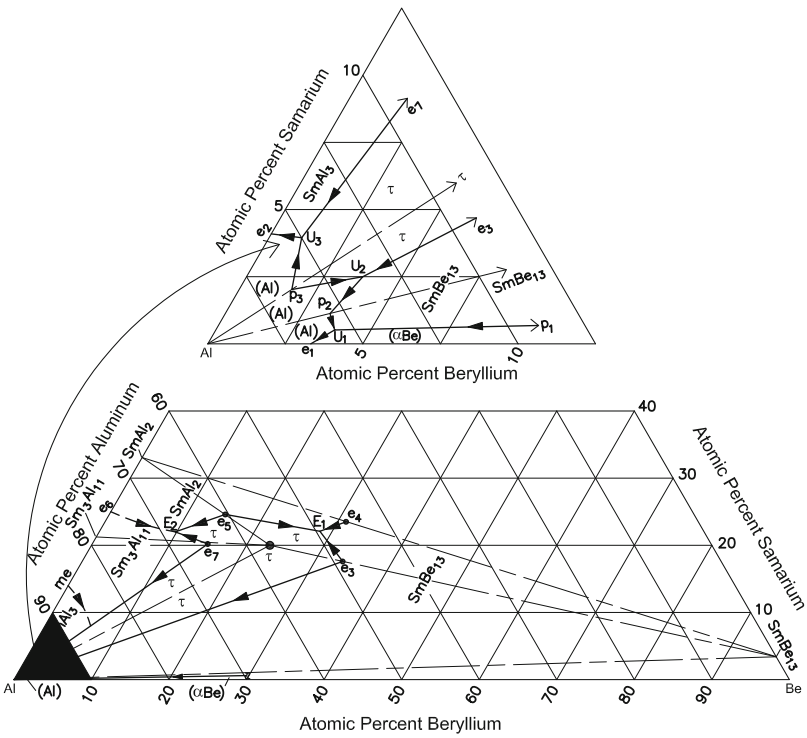

Fig. 1 Al-Be-Sm liquidus projection [2004Odi]

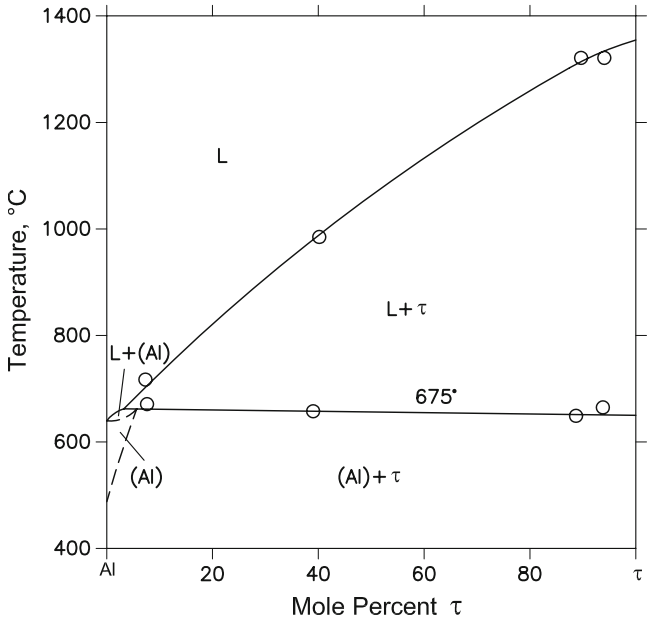

Fig. 2 Al-Be-Sm vertical section along Al-τ join [2004Odi]

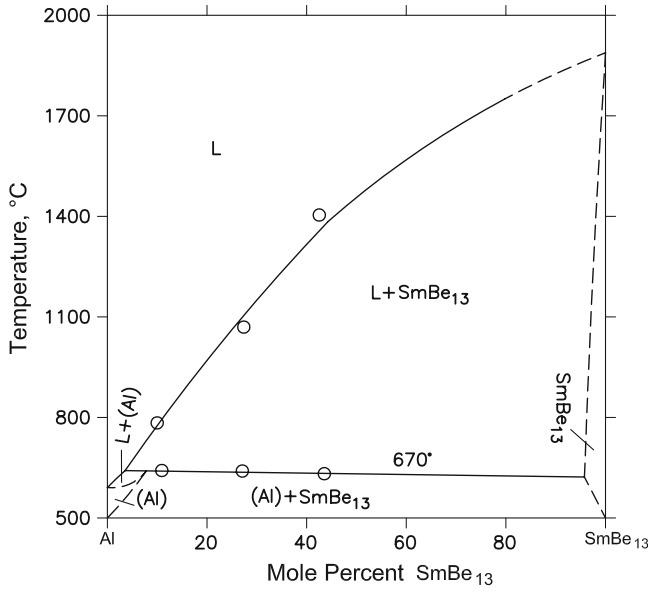

Fig. 3 Al-Be-Sm vertical section along Al-$SmBe_{13}$ join [2004Odi]

in Fig. 2 and 3. The peritectic temperatures are 675 and 670 °C, respectively. The peritectic compositions are 1.4 mol% τ and 1.3 mol% $SmBe_{13}$, respectively. The vertical sections along the τ-$SmBe_{13}$, $SmAl_2$-$SmBe_{13}$, τ-$SmAl_2$, and τ-Sm_3Al_{11} joins (not shown here) are of the simple eutectic type, with the eutectic temperatures at 1190, 1250, 1205, and 1150 °C, respectively.

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