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Al-Fe-Nb (Aluminum-Iron-Niobium)

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The early review of this system by [1987Rag] presented an isothermal section at 800 °C from the studies of [1966Ram] and [1970Bur]. The fcc-bcc equilibrium in Fe-rich alloys of this system was calculated by [1989Har] and isothermal sections were presented at 1250, 1150, 1050 and 950 °C. An unpublished study of this system by [1993Bej] (quoted by [2009Pal]) presented a partial liquidus projection. Recently, [2009Pal] determined three isothermal sections at 1150, 1000 and 800 °C for Fe-rich alloys, to clarify the bcc-Fe_2Nb and *B*2-Fe_2Nb equilibria.

Binary Systems

In the Fe-Al phase diagram [1993Kat], the solid solution γ based on face-centered cubic (fcc) Fe is restricted by a loop. The solid solution based on the body-centered cubic (bcc) Fe (α) exists in both the disordered (*A*2) and ordered (*B*2 and $D0_3$) forms. Apart from the high temperature phase ε ($D8_2$, Cu_5Zn_8-type cubic), there are three intermediate phases in the system with restricted ranges of homogeneity: $FeAl_2$ (triclinic), Fe_2Al_5 (orthorhombic) and $FeAl_3$ or Fe_4Al_{13} (monoclinic). The Al-Nb phase diagram [Massalski2] depicts the following intermediate phases: Nb_3Al (*A*15, Cr_3Si-type cubic), Nb_2Al ($D8_b$, σCrFe-type tetragonal) and $NbAl_3$ ($D0_{22}$, Al_3Ti-type tetragonal). The Fe-Nb phase diagram [2000Tof] has the following intermediate phases: Fe_2Nb (*C*14, $MgZn_2$-type hexagonal) and Fe_7Nb_6 ($D8_5$, Fe_7W_6-type rhombohedral).

Ternary Isothermal Sections

With starting metals of 99.9999% Al, 99.9% Fe and 99.99% Nb, [2009Pal] levitation/induction melted five alloys containing up to 10 at.% Nb and 40 at.% Al. The alloys were given a final anneal at 1150, 1000 and 800 °C for 100, 200 and 1000 h respectively and quenched in iced brine. The phase equilibria were studied with scanning electron microscopy, x-ray powder diffraction and electron probe microanalysis. The isothermal sections for Fe-rich alloys constructed by [2009Pal] at 1150, 1000 and 800 °C are shown in Fig. 1-3. At all the three temperatures, the *C*14 Laves phase (Fe_2Nb) is in equilibrium with bcc (or *B*2) phase. The solubility of Nb in bcc increases with increasing Al and even more so in *B*2. At 1150 °C (Fig. 1), a three-phase equilibrium was found, but the nature of the third phase is not known. [2009Pal] ruled out of the possibility of its being a Heusler-type phase. Lattice parameter measurements for the above phases were also reported by [2009Pal].

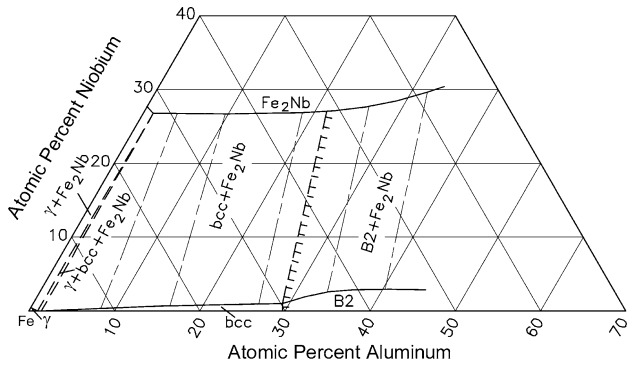

Fig. 2 Al-Fe-Nb partial isothermal section at 1000 °C for Fe-rich alloys [2009Pal]

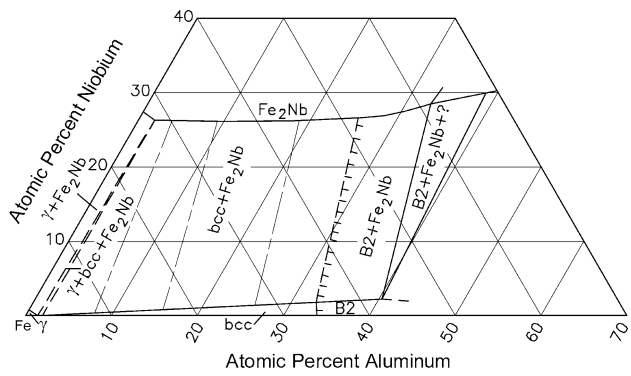

Fig. 1 Al-Fe-Nb partial isothermal section at 1150 °C for Fe-rich alloys [2009Pal]

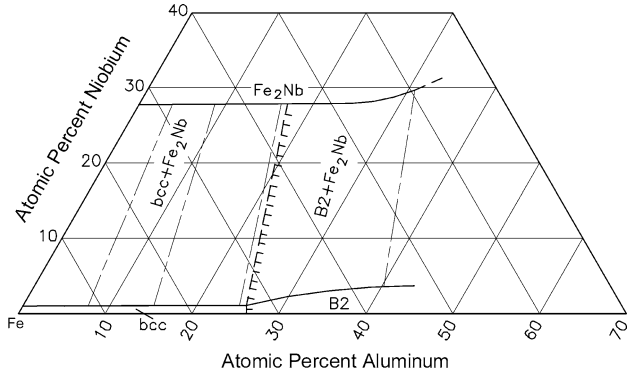

Fig. 3 Al-Fe-Nb partial isothermal section at 800 °C for Fe-rich alloys [2009Pal]

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