JPEDAV (2006) 27:511
DOI: 10.1361/154770306X136467
1547-7037/$19.00 ©ASM International

Al-Ir-Nb-Ni (Aluminum-Iridium-Niobium-Nickel)

V. Raghavan

Recently, a schematic partial phase diagram was reported by [2005Hua] for this system with data obtained from alloy samples annealed between 1250 and 2000 °C.

Binary Systems

The Al-Ir phase diagram [2000Oka] depicts four intermediate phases: IrAl (*B*2, CsCl-type cubic), $IrAl_{2.7}$ (cubic), $IrAl_3$ ($D0_{18}$, Na_3As-type hexagonal), Ir_4Al_{13} (monoclinic), and Ir_2Al_9 ($D8_d$, Co_2Al_9-type monoclinic). For brief descriptions of the Al-Nb, Al-Ni, and Nb-Ni phase diagrams, see [2006Rag]. See [Massalski2] for the Ir-Nb phase diagram. Ir_3Nb has the $L1_2$-type cubic structure. Ir and Ni form a continuous face-centered cubic (fcc) solid solution.

Ternary Systems

For the Al-Ir-Nb system, partial isothermal sections at 1100 °C were given by [1995Vil]. There appears to be no phase equilibrium data for the Al-Ir-Ni and Ir-Nb-Ni systems. An update of the Al-Nb-Ni system was given by [2006Rag].

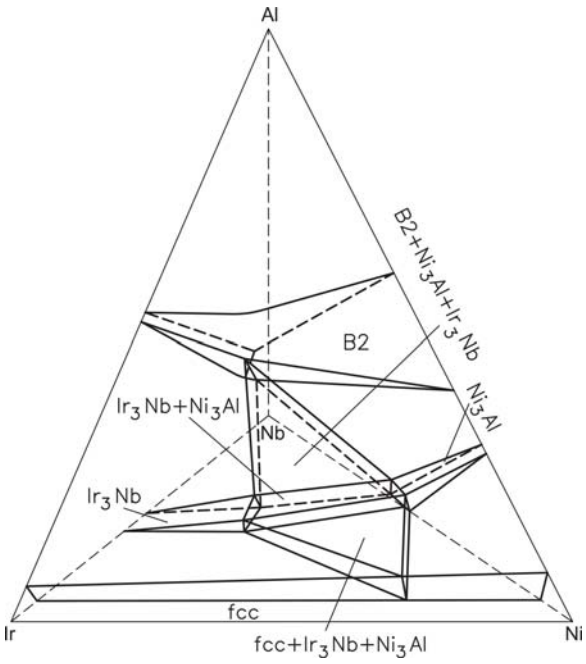

Fig. 1 Al-Ir-Nb-Ni schematic partial phase equilibria at ≥1250 °C [2005Hua]

Quaternary Phase Equilibria

In a series of papers [1999Yu, 2000Yu, 2002Hua, 2003Hua, 2005Hua], Huang et al. investigated the phase equilibria of this quaternary system. [2005Hua] arc melted 12 Ni-rich alloys and six Ir-rich alloys and annealed them up to 168 h between 1250 and 2000 °C. The phase equilibria were studied by scanning and transmission electron microscopy, x-ray diffraction, differential thermal analysis, and electron probe microanalysis. A schematic (partial) phase diagram applicable for ≥1250°C was constructed by [2005Hua] within the composition tetrahedron, Fig. 1. The continuous fcc solid solution between Ni and Ir dissolve some Al and Nb. The *B*2-type phases NiAl and IrAl also form a continuous solution. Ir_3Nb and Ni_3Al both with the $L1_2$-type structure show only limited solubility in each other, presumably due to the large difference in the lattice parameters (a = 0.38915 nm for Ir_3Nb and 0.35720 nm for Ni_3Al). Figure 1 shows two three-phase regions Ir_3Nb + Ni_3Al + fcc and Ir_3Nb + Ni_3Al + *B*2. Another related system Al-Ir-Nb-Pt investigated by [2005Hua] showed a continuous $L1_2$-type solid solution between Ir_3Nb and Pt_3Al (a = 0.38775 nm for Pt_3Al).

References

1995Vil: P. Villars, A. Prince, and H. Okamoto, Al-Ir-Nb, *Handbook of Ternary Alloy Phase Diagrams,* Vol. 4, ASM International, 1995, p 3824-3828

1999Yu: X.H. Yu, Y. Yamabe-Mitarai, and H. Harada, Phase Separation in Two Kinds of $L1_2$-Ni_3Al and Ir_3Nb of Refractory Superalloys, *Scr. Mater.,* 1999, **41**(11), p 1153-1159

2000Oka: H. Okamoto, Al-Ir (Aluminum-Iridium), *J. Phase Equilib. Diffus.,* 2000, **21**(4), p 409

2000Yu: X.H. Yu, Y. Yamabe-Mitarai, Y. Ro, and H. Harada, Design of Quaternary Ir-Nb-Ni-Al Refractory Superalloys, *Metall. Mater. Trans. A,* 2000, **31A,** p 173-178

2002Hua: C. Haung, K. Nishida, Y. Yamabe-Mitarai, and H. Harada, Equilibrium Phases at the Ir-Rich Corner of the Ir-Nb-Ni-Al Quaternary System, *Intermetallics,* 2002, **10,** p 893-902

2003Hua: C. Huang, Y. Yamabe-Mitarai, X.H. Yu, K. Nishida, and H. Harada, Investigation on the Phase Relationships in the Ir-Nb-Ni-Al System at the Ni-Rich side, *J. Alloys Compd.,* 2003, **360,** p 118-126

2005Hua: C. Huang, Y. Yamabe-Mitarai, X.H. Yu, S. Nakazawa, and H. Harada, Partial Phase Relationships in Ir-Nb-Ni-Al and Ir-Nb-Pt-Al Quaternary Systems and Mechanical Properties of Their Alloys, *Metall. Mater. Trans. A,* 2005, **36A,** p 539-545

2006Rag: V. Raghavan, Al-Nb-Ni (Aluminum-Niobium-Nickel), *J. Phase Equilib. Diffus.,* 2006, **27**(4), p 397-402