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Al-As-Ni (Aluminum-Arsenic-Nickel)

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The previous work on this ternary system is limited to a computed isothermal section at 25 °C by [1989Kli]. More recently, [1995Dep] determined an isothermal section at 800 °C, which depicts three ternary phases.

Binary Systems

The Al-As phase diagram [1984Mca] has one stoichiometric compound AlAs (*B*3, ZnS (sphalerite)-type cubic), which melts congruently at ~1760 °C. The Al-Ni phase diagram [1993Oka] shows five intermediate phases: $NiAl_3$ ($D0_{11}$, Fe_3C-type orthorhombic), Ni_2Al_3 ($D5_{13}$-type hexagonal), NiAl (*B*2, CsCl-type cubic, also denoted β), Ni_5Al_3 (Ga_3Pt_5-type orthorhombic), and Ni_3Al ($L1_2$, $AuCu_3$-type cubic; also denoted γ′). The As-Ni phase diagram [1987Sin] has five intermediate phases: Ni_5As_2 (hexagonal), $Ni_{11}As_8$ (tetragonal), NiAs ($B8_1$-type hexagonal), and two modifications of $NiAs_2$ with the transition temperature at ~600 °C. α$NiAs_2$ is orthorhombic (space group *Pbca*), and β$NiAs_2$ is a *C*18, FeS_2 (marcasite)-type orthorhombic phase.

Ternary Phases

[1989Kli] did not include any ternary phases in their computation of the phase equilibria of this system at 25 °C. [1995Dep] found three ternary phases in samples annealed at 800 °C and quenched in water. All three phases have hexagonal structures derived from the NiAs-type structure. Two of the phases denoted A and D, respectively, by [1995Dep] have fully disordered structure with the lattice parameters comparable to those of NiAs, whereas the B phase is a superstructure with $a = a' \sqrt{3}$ and $c = 3c'$, where a' and c' are the parameters of the NiAs subcell. The A phase has a composition range of $Ni_{2.2\text{-}3}Al_{0.35\text{-}0.6}As_{1.4\text{-}1.65}$ with $a = 0.3685$ to 0.3836 nm and $c = 0.5035$ to 0.5115 nm. The D phase has a range of $Ni_{3.5}Al_{0.8\text{-}1.5}As_{0.5\text{-}1.2}$ with $a = 0.3937$ to 0.3973 nm and $c = 0.5089$ to 0.5027 nm. The B phase has a composition range of $Ni_3Al_{0.5\text{-}0.85}As_{1.5\text{-}1.15}$ with $a = 0.6661$ to 0.6687 nm and $c = 1.5321$ to 1.5318 nm.

Isothermal Section

With starting materials of purity ≥99.9%, [1995Dep] arc melted about 20 ternary alloys in Ar atm. The alloy samples were given a final anneal at 800 °C for 20 days and quenched in water. The phase equilibria were studied by x-ray powder diffraction and electron probe microanalysis. The compositions of the coexisting phases were listed. The isothermal section constructed by [1995Dep] at 800 °C is redrawn in Fig. 1. The Ni-Al and Ni-As binary compounds

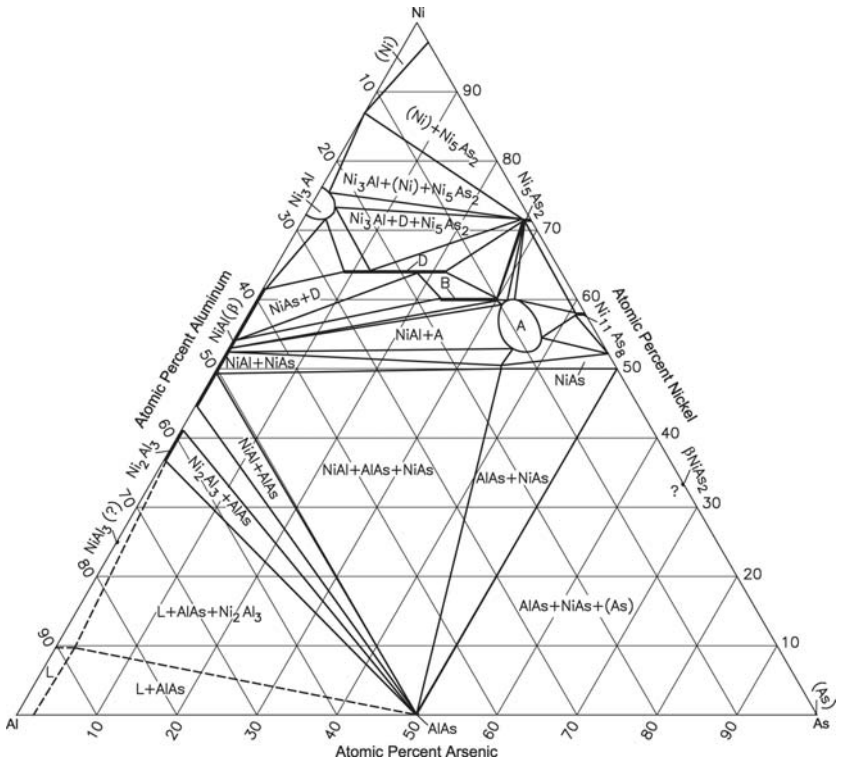

Fig. 1 Al-As-Ni isothermal section at 800 °C [1995Dep]

show very limited solubility for the third component, with the exception of NiAs, which dissolves Al up to the composition $NiAs_{0.7}Al_{0.3}$. The three ternary phases and (Ni) do not form tie-lines with AlAs. The phases NiAl, Ni_2Al_3, and NiAs form tie-lines with AlAs.

[1995Dep] also determined an approximate isothermal section at 800 °C for the Al-As-Ga-Ni quaternary system at the constant composition of $Ga_{0.7}As_{0.3}$ and compared it with the section for this ternary system as well as that for the As-Ga-Ni system [1989Gue].

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