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Al-Co-Ni-Ti (Aluminum-Cobalt-Nickel-Titanium)

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The phase equilibria between the $B2$ and $L2_1$ phases in this quaternary system was investigated by [2002Ish] and reviewed by [2005Rag]. Recently, [2008Cui] investigated the fcc-$L1_2$ relationships between 1100 and 750 °C. The precipitation of disordered fcc particles in the $L1_2$ matrix has been studied in alloys of this quaternary system earlier, see for example [1997Liu].

Lower Order Systems

Brief descriptions of the relevant binary systems can be found in [Massalski2]. Data on Al-Co-Ni, Al-Co-Ti, Al-Ni-Ti, and Co-Ni-Ti ternary systems were compiled by Villars et al. [1995Vil].

Quaternary Phase Equilibria

[2008Cui] prepared five quaternary alloys by mixing two base alloys of Ni-Al and Co-Ti. The alloys were given a final anneal of 32 h at 1100 °C or 1000 h at 750 °C. The phase equilibria were studied by scanning and transmission electron microscopy and x-ray powder diffraction. The compositions of the coexisting phases were measured by energy dispersive x-ray spectroscopy attached to the scanning electron microscope.

In the phase equilibria of interest here, Co and Ni form a continuous face-centered cubic (fcc) solid solution γ, which dissolves a few percent each of Al and Ti. The γ′ ($L1_2$) phases Ni_3Al and Co_3Ti form a continuous solid solution. The measured tie-line compositions between γ (fcc) and γ′ ($L1_2$) at 1100 °C are listed in Table 1 for the five quaternary alloys [2008Cui]. The (Ni + Co) content approximates to 75 at.% and (Al + Ti) content is ~25 at.%, corresponding to the formula $(Ni,Co)_3(Al,Ti)$. Figure 1 shows schematically the phase relationships in a tetrahedron and is valid for the temperature range of 750 to 1100 °C.

Table 1 Measured tie-lines of Al-Co-Ni-Ti alloys at 1100 °C [2008Cui]

	Composition, at.%			
Phase/Alloy	**Al**	**Co**	**Ni**	**Ti**
Alloy20(a)	14.5	15.1	66.5	3.8
γ (fcc)	14.6	18.9	63.6	2.9
γ′ ($L1_2$)	18.1	12.4	64.8	4.7
Alloy40(a)	11.1	30.8	50.5	7.6
γ (fcc)	12.4	33.2	47.5	6.9
γ′ ($L1_2$)	14.2	26.7	49.8	9.3
Alloy50(a)	9.3	38.7	42.4	9.6
γ (fcc)	9.4	44.1	39.0	7.5
γ′ ($L1_2$)	11.2	33.7	43.6	11.5
Alloy60(a)	7.6	46.7	34.1	11.6
γ (fcc)	8.2	50.5	31.6	9.7
γ′ ($L1_2$)	8.9	42.7	35.3	13.1
Alloy80(a)	3.7	63.1	17.4	15.8
γ (fcc)	5.0	69.6	13.1	12.4
γ′ ($L1_2$)	4.7	61.8	15.4	18.0

(a) Alloy designations as used by [2008Cui]

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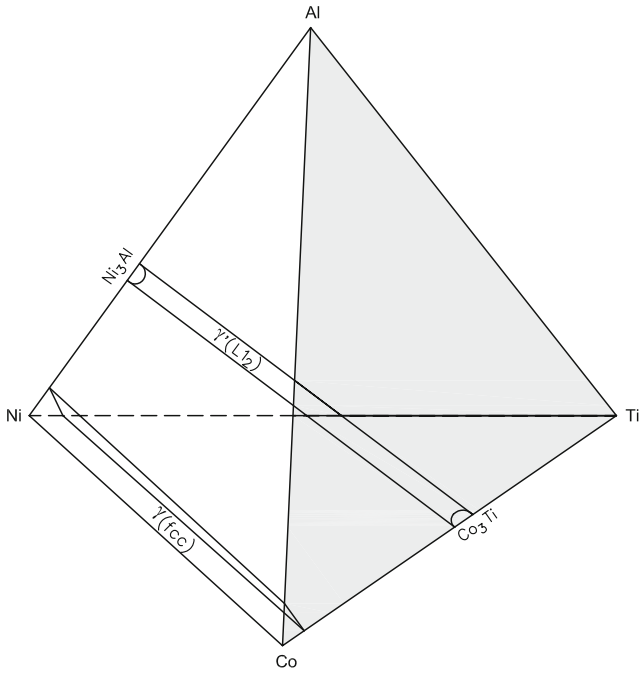

Fig. 1 Al-Co-Ni-Ti schematic γ (fcc) - γ′ ($L1_2$) equilibrium between 1100 and 750 °C [2008Cui]

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