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Al-Cu-N-Ti (Aluminum-Copper-Nitrogen-Titanium)

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[1997Dur] investigated the phase relationships in this quaternary system at 850 °C and presented a schematic table of the interrelationships between the tie-tetrahedra and the adjoining three-phase fields of the system.

Binary Systems

For brief descriptions of the Al-Cu, Al-Ti, and Cu-Ti phase diagrams, see the update on the Al-Cu-Ti system in this issue. See the Al-N-Ti update for descriptions of the Al-N and Ti-N phase diagrams. No intermediate phase was found at 850 °C in the Cu-N system [1997Dur].

Ternary Systems

Updates on the Al-Cu-Ti and Al-N-Ti systems appear in this issue. In the Al-Cu-N system, no ternary phases were found at 600 °C [1997Dur]. An isothermal section of the Cu-N-Ti system at 850 °C determined by [1997Dur] is shown in Fig. 1. It depicts a ternary phase Ti_3CuN of tetragonal symmetry (denoted *T* here), with $a = 1.1968$ nm and $c = 0.30217$ nm.

Quaternary Phase Equilibria

With starting materials of 99.999% Al, 99.999% Cu, 99% or 99.9% Ti, 99% AlN, and 99% AlTi, [1997Dur] arc-melted under Ar atm about 100 quaternary alloys. The alloys were annealed at 850 °C for 120 h and quenched in water. The composition of the phases was determined by energy dispersive x-ray analysis on a scanning electron microscope or on a microprobe. The structural analysis was done by x-ray powder diffraction. A number of three-phase equilibria and 18 four-phase equilibria were determined and listed. A network of three-phase spaces and 29 four-phase spaces proposed by [1997Dur] at 850 °C is shown in Fig. 2. Experimentally determined four-phase spaces are in solid-outlined boxes. The four-phase spaces inferred and corroborated by calculation are shown in dashed boxes. The three-phase fields originating from the ternary systems are shaded gray. Most of the three-phase equilibria of the ternary systems are accounted, except for a few omissions such as the triangulations involving the Cu_3Ti_2 and Ti_2N. In five three-phase spaces that lie entirely within the composition tetrahedron, their further links with other phase spaces are not known.

The quaternary η-type cubic phase is the dominating phase in the system, occurring in 21 four-phase spaces, of which 14 are experimentally observed [1997Dur]. [1989Car] first reported this phase with the general formula $(Ti_{3-x}Cu_{3-x}Al_{2x})_6N$, space group $Fd\bar{3}m$ and lattice parameter of 1.13 nm. When in equilibrium with various phases of this quaternary system, [1997Dur] found the η phase to have a wide homogeneity range and a lattice parameter of 1.1279-1.1368 nm. [1997Dur] obtained a single-phase material at the composition $Ti_3Cu_2Al_1N_{0.8}$ with $a = 1.1339$ nm. The presence of a fifth phase in some cases was attributed by [1997Dur] to oxygen contamination and the formation of an η-type oxide phase.

References

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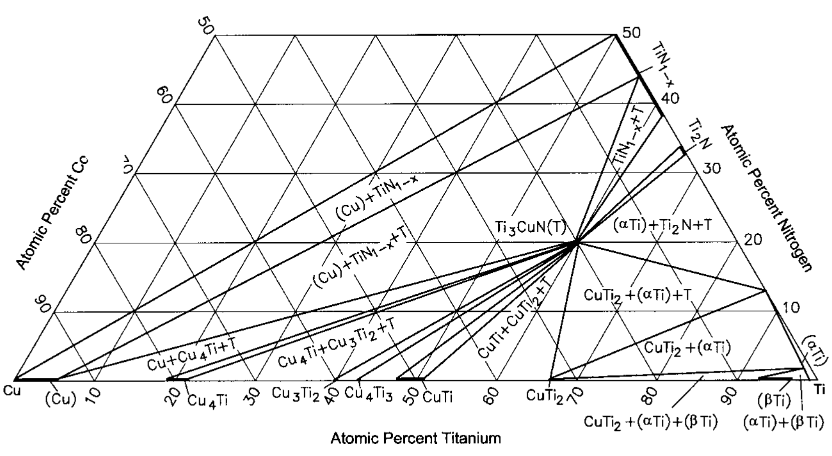

Fig. 1 Cu-N-Ti isothermal section at 850 °C [1997Dur]

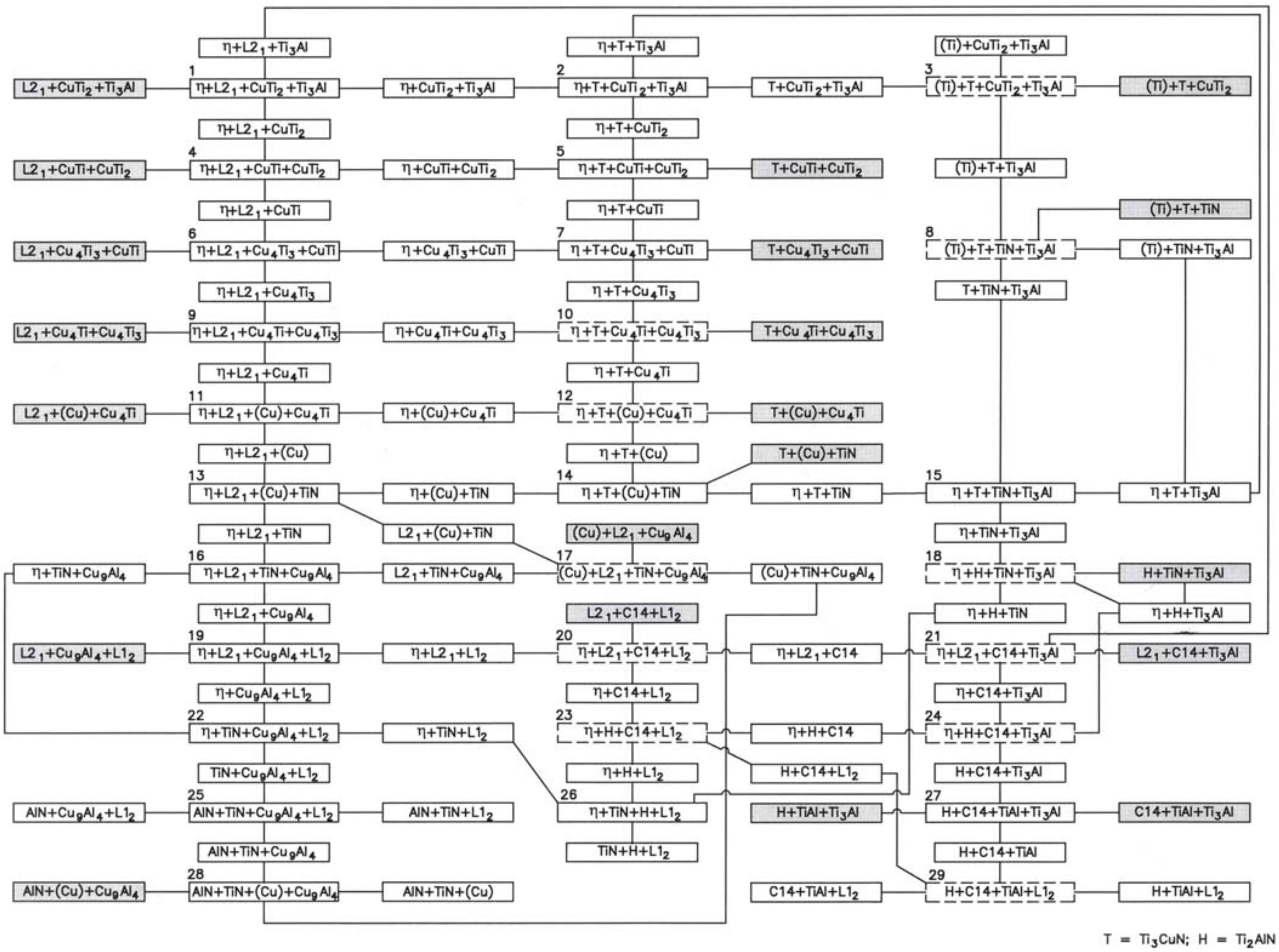

Fig. 2 Al-Cu-N-Ti network of three-phase and four-phase spaces at 850 °C [1997Dur]