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Al-Mo-Ni-Ta (Aluminum-Molybdenum-Nickel-Tantalum)

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Directionally solidified multiphase eutectics containing ordered intermetallics are of interest in high-temperature applications. [1995Joh] explored the possibility of such eutectics containing a metallic phase for improved room-temperature toughness and one or more intermetallics for high-temperature strength. The characteristics of the NiAl-NiAlTa-Mo ternary eutectic of this quaternary system were studied.

Binary Systems

Brief descriptions of the Al-Mo, Al-Ni, and Mo-Ni phase diagrams are given in the Al-Mo-Ni update in this issue. The Al-Ta and Ni-Ta phase diagrams are described in the Al-Ni-Ta update in this issue. The Mo-Ta phase diagram [Massalski2] depicts a continuous body-centered-cubic solid solution between Mo and Ta.

Ternary Systems

Updates on the Al-Mo-Ni and Al-Ni-Ta systems appear in this issue. The Al-Mo-Ta phase diagram is not known. The review of the Mo-Ni-Ta system by [1991Gup] presented a partial liquidus projection and partial isothermal sections at 1250, 1000, and 900 °C.

Quaternary Phase Equilibria

Using high-purity Al, Mo, Ni, and Ta metals, [1995Joh] prepared a number of alloy compositions by induction and arc melting. By metallographic examination, 15 alloy compositions were bracketed to yield the maximum volume fraction of the eutectic mixture. Directional solidification was then done by electromagnetic levitation. The constrained liquid zone moving at 19 mm/h produced near-equilibrium microstructures. The longitudinal microstructure of a directionally solidified alloy showed a lamellar/fibrous morphology of the ternary eutectic of NiAl-NiAlTa-(Mo,Ta). Annealing of the eutectic structure around 1400 °C showed no signs of coarsening and no evidence of a solid-state transformation.

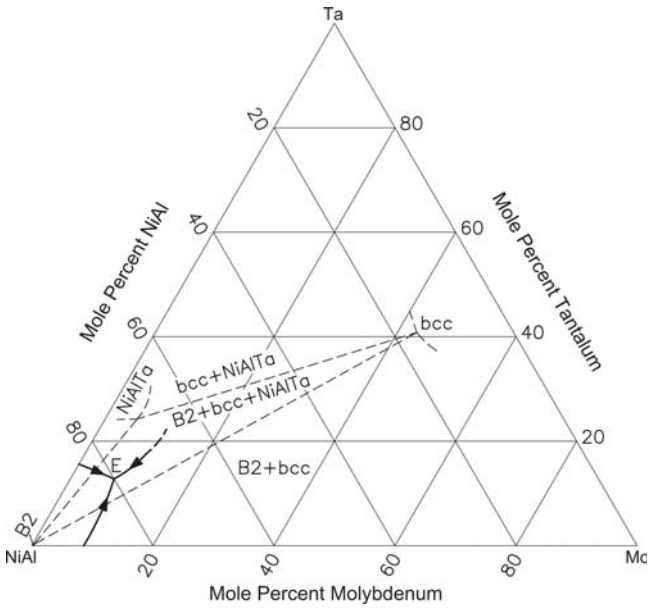

Fig. 1 Al-Mo-Ni-Ta partial liquidus projection on the NiAl-Mo-Ta plane [1995Joh]

The tentative liquidus projection constructed by [1995Joh] is shown in Fig. 1 on a triangular section of the composition tetrahedron obtained by joining NiAl to Mo and Ta corners. The phase distribution at the undetermined eutectic temperature is shown schematically in Fig. 1. E is the composition of the eutectic liquid.

References

1991Gup: K.P. Gupta, The Mo-Ni-Ta (Molybdenum-Nickel-Tantalum) System, *Phase Diagrams of Nickel Ternary Alloys,* Part 2, Ind. Inst. Metals, Calcutta, 1991, p 92-107

1995Joh: D.R. Johnson, B.F. Oliver, R.D. Noebe, and J.D. Whittenberger, NiAl-Based Polyphase in situ Composites in the NiAl-Ta-*X* (*X* = Cr, Mo, or V) Systems, *Intermetallics,* 1995, **3,** p 493-503