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Al-Fe-Tb (Aluminum-Iron-Terbium)

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Recently, Yanson et al. [2001Yan] studied the phase relationships in this system at 500 °C in a narrow region around 10.5 at.% Tb. Here, the structurally related phases of the types Th_2Ni_{17}, Th_2Zn_{17}, and $TbCu_7$ occur close to one another.

Binary Systems

The Al-Fe phase diagram [1993Kat] shows that the face-centered-cubic (fcc) solid solution based on Fe is restricted by a γ loop. The body-centered-cubic (bcc) solid solution α exists in the disordered *A*2 form, as well as the ordered *B*2 and $D0_3$ forms and extends up to 50 at.% Al at the temperature of interest here (500 °C). In the Fe-Tb system [1993Oka], there are four intermediate phases. The Th_2Ni_{17}-type hexagonal phase Tb_2Fe_{17} (denoted here 2:17H) is stable at stoichiometric and at Fe-rich compositions and the Th_2Zn_{17}-type rhombohedral phase 2:17R is stable at Tb-rich compositions [2001Yan]. The other three phases are the Th_6Mn_{23}-type cubic phase Tb_6Fe_{23}, the $PuNi_3$-type rhombohedral phase $TbFe_3$, and the $MgCu_2$-type cubic phase $TbFe_2$.

Ternary Isothermal Section

With starting metals of purity of not less than 99.9%, [2001Yan] melted about 65 alloy compositions in an arc furnace under Ar atm. Three series of compositions were prepared at 9.5, 10.5, and 11.5 at.% Tb and at 2.5 at.% Al intervals up to 50 at.% Al. Some samples were also prepared at 5 and 15 at.% Tb. The samples were given a final anneal at 500 °C for 720 h and quenched in water. The phase equilibria were studied by x-ray powder diffraction.

At 9.5 at.% Tb, the 2:17H phase, the $TbCu_7$ type hexagonal phase 1:7, and the 2:17R phase are stable in the ranges of 0-18, 20.5-23, and 43-50.5 at.% Al, respectively. At 10.5 at.% Tb, they cover the concentration ranges of 0-18, 20.5-22.5, and 40-49.5 at.% Al, respectively. At 11.5 at.% Tb, only the 2:17R phase is stable and covers the composition range of 0-43.5 at.% Al. The influence of the geometrical factors on the structural stability of these phases was discussed by [2001Yan].

Due to the narrow range of the Tb content and the extensive line overlap in the x-ray patterns of the closely-related structures, the identification of the two-phase fields or of the presence of other closely-related structure variants such as the rhombohedral $PrFe_7$ type could not be done. A single plot of the subcell parameters of all the three structures indicated a continuous increase in the *a* and *c* parameters with increasing Al content [2001Yan].

The partial isothermal section at 500 °C constructed by [2001Yan] is redrawn in Fig. 1. The ordered forms of Fe-Al bcc phase α are not shown separately from α. The three phases 2:17H, 1:7, and 2:17R are "in equilibrium with the neighboring solid solutions α, $Tb(Al,Fe)_2$ and $Tb(Fe,Al)_{12}$ and an unidentified ternary phase," [2001Yan]. As seen in Fig. 1, these equilibria are sketched schematically by [2001Yan] without labeling the phase fields. The details are not known.

References

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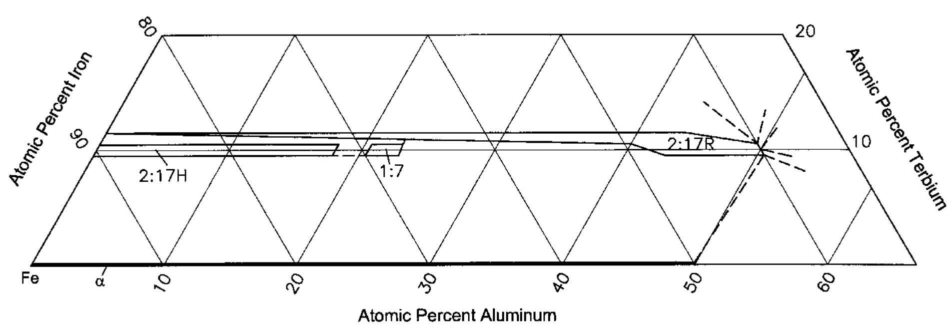

Fig. 1 Al-Fe-Tb partial isothermal section at 500 °C [2001Yan]