Fe-Gd-Nb (Iron-Gadolinium-Niobium)

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An isothermal section for this system was determined by [1995Zhu] at 500 °C. This section depicts one ternary compound $GdFe_{11}Nb$.

Binary Compounds

An updated version of the Fe-Gd phase diagram is given by [1998Zha]. There are four line compounds in this system: $Fe_{17}Gd_2$, $Fe_{23}Gd_6$, Fe_3Gd, and Fe_2Gd. [1993Bej] reinvestigated the Fe-Nb phase diagram. The homogeneity ranges of the compounds of this system, Fe_2Nb and Fe_7Nb_6, used in this review are taken from their work. There are no intermediate phases in the Gd-Nb system and the mutual solubility between Gd and Nb is negligible.

Ternary Isothermal Section

With starting metals of purity 99.95% Fe, 99.9% Gd, and 99.9% Nb, [1995Zhu] melted 133 alloy samples in an induction furnace under Ar atm. The alloys were homogenized at 800 °C for 40 days and annealed further at 500 °C for 10 days; they were then quenched in an ice-water mixture. The phase equilibria were studied mainly by x-ray powder diffraction. Their isothermal section at 500 °C is redrawn in Fig. 1 to agree with the accepted binary data. One ternary compound $GdFe_{11}Nb$ (denoted herein 1:12) is present at this temperature. This compound has the $ThMn_{12}$-type tetragonal structure. The maximum solubility of Gd in Fe_2Nb and Fe_7Nb_6 and that of Nb in $Fe_{17}Gd_2$ are 1.8, 1.2, and 2.1 at.%, respectively [1995Zhu].

It is interesting to compare Fig. 1 with the isothermal section at ~25 °C determined by [1998Hua] (reviewed by [2000Rag]). At ~25 °C, two ternary compounds, $GdFe_{11.4}Nb_{0.6}$ (1:12) and $Gd_3(Fe,Nb)_{29}$, (3:29) are present. Also, in samples annealed at 700 °C, [1998Hua] found both compounds. On the other hand, the isothermal section at 500 °C (Fig. 1) depicts only the 1:12 phase. [1998Hua] noted that the 3:29 compound in other similar systems such as Fe-Nd-Ti is stable only at elevated temperatures in contrast to its stability at room temperature found by them in the Fe-Gd-Nb system. Clearly, the results of [1995Zhu] and [1998Zha] are contradictory and further experimental evidence is required to conclude whether the 3:29 phase is stable at low temperatures.

References

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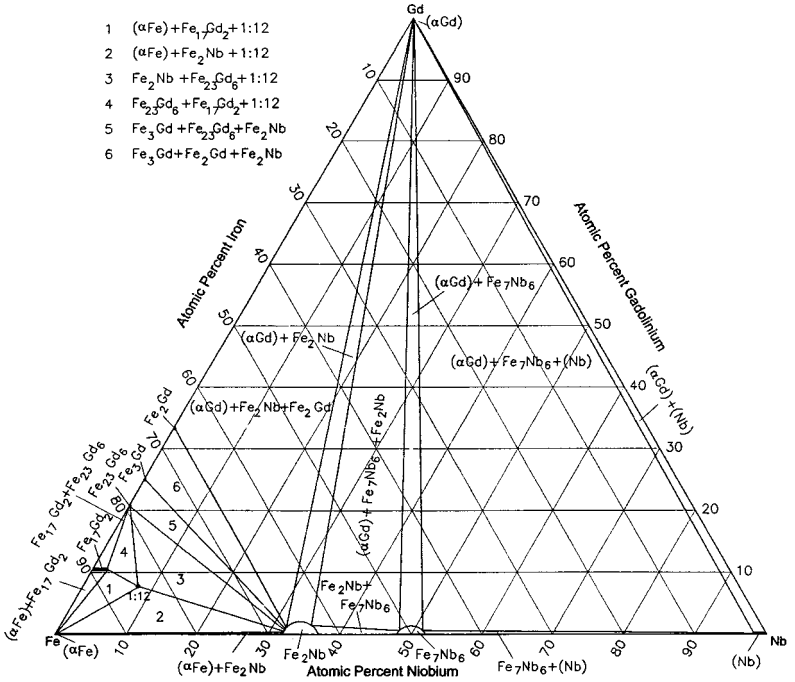

Fig. 1 Fe-Gd-Nb isothermal section at 500 °C [1995Zhu]. The thin two-phase fields around tie-triangles are omitted