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Fe-Gd-Ti (Iron-Gadolinium-Titanium)

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The previous results on this system by [1992Tia] and [1998Huo] were reviewed by [2000Rag], who presented two partial isothermal sections for Fe-rich alloys at 1100 and 25 °C. Recently, [2009Ma] reinvestigated this system and determined an isothermal section at 500 °C.

Binary Systems

The Fe-Gd phase diagram [1998Zha] depicts the following compounds: $\alpha Fe_{17}Gd_2$ (Th_2Zn_{17}-type rhombohedral), $\beta Fe_{17}Gd_2$ (Th_2Ni_{17}-type hexagonal), $Fe_{23}Gd_6$ ($D8_a$, $Mn_{23}Th_6$-type cubic), Fe_3Gd (Be_3Nb-tye rhombohedral) and Fe_2Gd ($C15$, $MgCu_2$-type cubic). The temperature range of stability of $Fe_{23}Gd_6$ is not firmly established [1998Zha]. The Fe-Ti phase diagram [1998Dum] depicts two intermediate phases: Fe_2Ti ($C14$, $MgZn_2$-type hexagonal) and FeTi ($B2$, CsCl-type cubic). The Gd-Ti phase diagram [Massalski2] depicts a liquid miscibility and no intermediate phases.

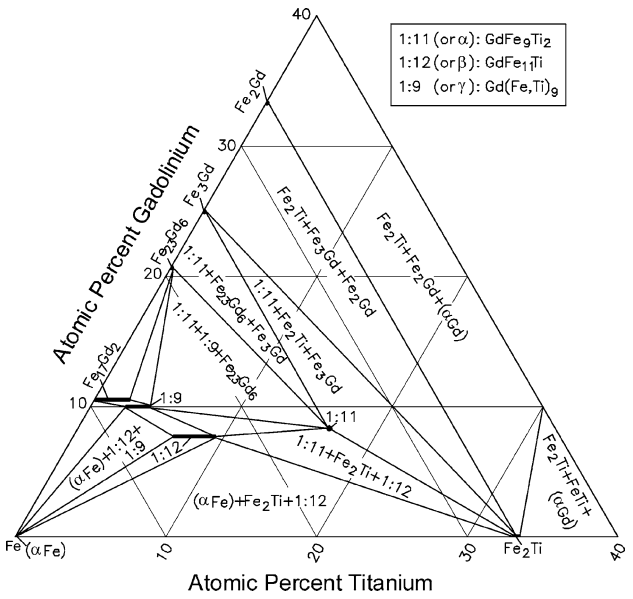

Fig. 1 Fe-Gd-Ti isothermal section at 500 °C for Fe-rich alloys [2009Ma]. Narrow two-phase regions are omitted

Ternary Compounds

The structural characteristics of the four known compounds in this system were summarized by [2000Rag]. These were denoted as 1:11 ($GdFe_9Ti_2$, $CeMn_6Ni_5$-type tetragonal), 1:12 ($GdFe_{11}Ti$, $ThMn_{12}$-type tetragonal), 1:9 ($Gd(Fe,Ti)_9$), and 3:29 ($Gd_3(Fe,Ti)_{29}$, $Nd_3(Fe,Ti)_{29}$-type monoclinic). The first three of these were confirmed by [2009Ma] at 500 °C, who denoted them as α, β, and γ respectively. The fourth compound $Gd_3(Fe,Ti)_{29}$ found at 1100 °C by [1998Huo] is not stable at 500 °C [2009Ma]. The compound 1:9 (γ) has the Cu_7Tb-type hexagonal structure, with lattice parameters of a = 0.4904 nm and c = 0.4193 nm [2009Ma].

Ternary Isothermal Section

With starting metals of 99.95% Fe, 99.95% Gd and 99.99% Ti, [2009Ma] arc-melted under Ar atm 47 alloy buttons. The samples were given a final anneal at 700 °C for 240 h and quenched in liquid nitrogen. The phase equilibria were studied with x-ray powder diffraction. The isothermal section at 500 °C constructed by [2009Ma] is shown in Fig. 1. The compound 1:9 (γ) has a range of homogeneity from $Gd(Fe_{0.974}Ti_{0.026})_9$ to $Gd(Fe_{0.956}Ti_{0.044})_9$. $Fe_{17}Gd_2$ dissolves up to about 2.3 at.% Ti.

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