JPEDAV (2010) 31:173–174
DOI: 10.1007/s11669-010-9648-1
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Fe-Ga-Gd (Iron-Gallium-Gadolinium)

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Recently, [2009Liu] determined an isothermal section at 500 °C for this ternary system, which depicts two ternary compounds along the isoconcentrate line of 7.7 at.% Gd.

Binary Systems

The Fe-Ga phase diagram [2004Oka, Massalski2] has the following intermediate phases: α′ (*B*2, CsCl-type cubic), α″ ($D0_3$, BiF_3-type cubic), αFe_3Ga ($L1_2$, $AuCu_3$-type cubic), βFe_3Ga ($D0_{19}$, Ni_3Sn-type hexagonal), αFe_6Ga_5 (Fe_6Ge_5-type monoclinic), βFe_6Ga_5 ($D8_{10}$, Al_8Cr_5-type rhombohedral), Fe_3Ga_4 (monoclinic) and $FeGa_3$ ($CoGa_3$-type tetragonal). The Fe-Gd phase diagram [1998Zha] depicts the following compounds: α$Fe_{17}Gd_2$ (Th_2Zn_{17}-type rhombohedral), β$Fe_{17}Gd_2$ (Th_2Ni_{17}-type hexagonal), $Fe_{23}Gd_6$ ($D8_a$, $Mn_{23}Th_6$-type cubic), Fe_3Gd (Ni_3Pu-tye rhombohedral) and Fe_2Gd (*C*15, $MgCu_2$-type cubic). The temperature range of stability of $Fe_{23}Gd_6$ is not firmly established [1998Zha]. [2009Liu] did not find this compound at 500 °C. The Ga-Gd phase diagram [Massalski2] has the following intermediate phases: $GdGa_6$ ($PuGa_6$-type tetragonal), $GdGa_2$ (22-33.3 at.% Gd; *C*32, AlB_2-type hexagonal), GdGa (B_f, CrB-type orthorhombic), Gd_3Ga_2 (Gd_3Ga_2-type tetragonal) and Gd_5Ga_3 ($D8_l$, Cr_5B_3-type tetragonal).

Ternary Compounds

Two ternary compounds are stable in this system at 500 °C [2009Liu]: $GdFe_{5.3}Ga_{6.7}$ ($ScFe_6Ga_6$-type orthorhombic, space group *Immm*, lattice parameters: a = 0.85676 nm, b = 0.86960 nm and c = 0.50782 nm, denoted as τ_1 here and as δ by [2009Liu]) and $GdFe_5Ga_7$ ($ThMn_{12}$-type tetragonal, a = 0.8651 nm and c = 0.50934 nm, denoted τ_2 here and ε by [2009Liu]). Both these compounds are present at a constant Gd content of 7.7 at.%. $GdFe_5Ga_7$ shows a homogeneity range of 53.8-59.2 at.% [2009Liu], which corresponds to a range of $GdFe_5Ga_7$-$GdFe_{4.3}Ga_{7.7}$.

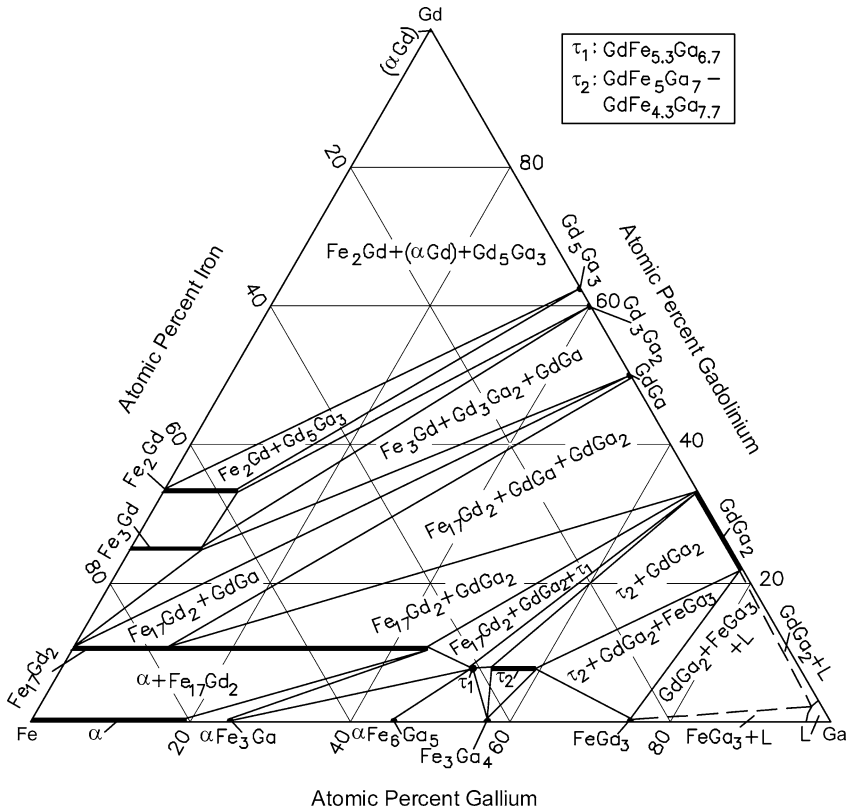

Fig. 1 Fe-Ga-Gd isothermal section at 500 °C [2009Liu]. Narrow two-phase regions are omitted

Isothermal Section

With starting metals of 99.99+% purity, [2009Liu] arc-melted about 130 alloys under Ar atm. The samples were given a final anneal at 500 °C for 3 days and quenched in liquid nitrogen. The phase equilibria were studied with x-ray powder diffraction. The isothermal section constructed by [2009Liu] at 500 °C is shown in Fig. 1. The ternary compounds τ_1 and τ_2 are present. The binary compounds Fe_2Gd, Fe_3Gd and $\alpha Fe_{17}Gd_2$ dissolve up to 9.2, 9 and 44.3 at.% Ga respectively. The other binary compounds do not show any ternary solubility. The compound $GdGa_6$ is not stable at this temperature. $Fe_{23}Gd_6$ was not detected at 500 °C [2009Liu]. No homogeneity ranges were reported by [2009Liu] for αFe_3Ga, αFe_6Ga_5 and Fe_3Ga_4 binary compounds.

References

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