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Fe-Ga-Tb (Iron-Gallium-Terbium)

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Recently, [2009Li] determined an isothermal section at 500 °C for this ternary system, which depicts six ternary compounds.

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-Tb phase diagram [Massalski2] depicts the following compounds: α$Fe_{17}Tb_2$ (Th_2Zn_{17}-type rhombohedral), β$Fe_{17}Tb_2$ (Th_2Ni_{17}-type hexagonal), $Fe_{23}Tb_6$ ($D8_a$, $Mn_{23}Th_6$-type cubic), Fe_3Tb (Be_3Nb-type rhombohedral) and Fe_2Tb (*C*15, $MgCu_2$-type cubic). The Ga-Tb phase diagram [Massalski2] depicts the following compounds: Ga_6Tb (tetragonal), αGa_3Tb ($D0_{19}$, Ni_3Sn-type hexagonal), βGa_3Tb ($L1_2$, $AuCu_3$-type cubic), Ga_2Tb (*C*32, AlB_2-type hexagonal), GaTb (B_f, CrB-type orthorhombic) and Ga_3Tb_5 ($D8_l$, Cr_5B_3-type tetragonal).

Ternary Compounds

Six ternary compounds are known in this system: $TbFe_{0.32}Ga_{1.68}$ (labeled τ_1 here and as α by [2009Li]), $TbFe_{2.4}Ga_{0.6}$ (τ_2 or β), Tb_4FeGa_{12} (τ_3 or γ), Tb_2FeGa_8 (τ_4 or η), $TbFe_6Ga_6$ (τ_5 or λ), and $TbFe_5Ga_7$ (τ_6 or θ). The structural characteristics of these compounds are listed in Table 1. The compounds Tb_2FeGa_8 (τ_4 or η) and $TbFe_6Ga_6$ (τ_5 or λ) were known earlier and confirmed by [2009Li]. The other compounds were reported for the first time by [2009Li] in alloys annealed at 500 °C.

Isothermal Section

With starting metals of 99.9+% purity, [2009Li] arc-melted about 220 samples under Ar atm. The alloys were given a final anneal at 500 °C for 3 days and quenched in liquid nitrogen. The phase equilibria were studied by x-ray powder diffraction. The isothermal section constructed by [2009Li] at 500 °C is shown in Fig. 1. All six ternary compounds are present. A number of them show a small homogeneity range around the nominal composition listed

Table 1 Fe-Ga-Tb crystal structure and lattice parameter data [2009Li]

Phase	Composition, at.%	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$TbFe_{0.32}Ga_{1.68}$ ($\tau_1$or α)	10.7 Fe 56 Ga 33.3 Tb	*hP*6	$P6_3/mmc$	Ni_2In	a = 0.43727 c = 0.72930
$TbFe_{2.4}Ga_{0.6}$ ($\tau_2$or β)	60 Fe 15 Ga 25 Tb	*hP*24	$P6_3/mmc$	$CeNi_3$	a = 0.51877 c = 1.6621
Tb_4FeGa_{12} ($\tau_3$or γ)	5.9 Fe 70.6 Ga 23.5 Tb	*cI*34	$Im\bar{3}m$	$U_4Re_7Si_6$	a = 0.85576
Tb_2FeGa_8 ($\tau_4$or η)	9.1 Fe 72.7 Ga 18.2 Tb	*tP*11	*P*4/*mmm*	Ho_2CoGa_8	a = 0.42678 c = 1.1131
$TbFe_6Ga_6$ ($\tau_5$or λ)	46.15 Fe 46.15 Ga 7.7 Tb	*oI*26	*Immm*	$ScFe_6Ga_6$	a = 0.85551 b = 0.86826 c = 0.50717
$TbFe_5Ga_7$ ($\tau_6$or θ)	38.5 Fe 53.8 Ga 7.7 Tb	*tI*26	*I*4/*mmm*	$ThMn_{12}$	a = 0.86779 c = 0.50923

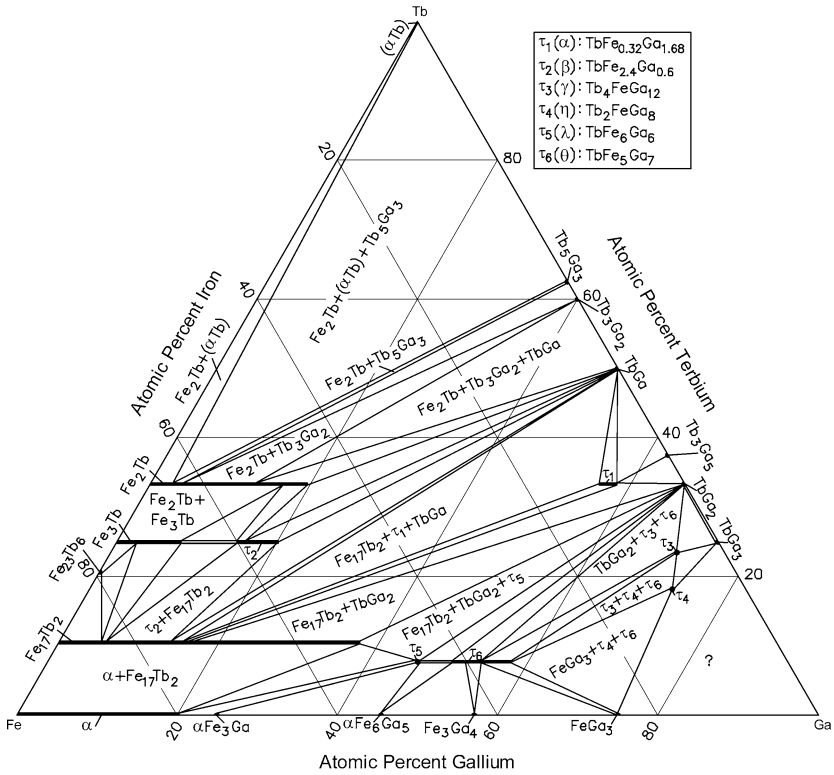

Fig. 1 Fe-Ga-Tb isothermal section at 500 °C [2009Li]. Narrow two-phase regions are omitted

in Table 1. The Fe-Tb binary compounds Fe_2Tb, Fe_3Tb, and $Fe_{17}Tb_2$ dissolve up to 19.6, 8, and 37.5 at.% Ga, respectively. The third component solubility in the other binary compounds is small. The compound Ga_6Tb is not stable at this temperature. No homogeneity ranges were reported by [2009Li] for αFe_3Ga, αFe_6Ga_5, and Fe_3Ga_4 binary compounds.

References

2004Oka: H. Okamoto, Fe-Ga (Iron-Gallium), *J. Phase Equilib. Diffus.*, 2004, **25**(1), p 100

2009Li: J.Q. Li, M. Ouyang, D.C. Liu, F.S. Liu, and W.Q. Ao, The Isothermal Section of the Tb-Fe-Ga Ternary System at 773 K, *Intermetallics*, 2009, **17**, p 733-737