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Co-Fe-Ga (Cobalt-Iron-Gallium)

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The phase equilibria of this system were investigated by [2007Duc] with particular reference to the order-disorder transitions and magnetic transitions in the bcc phase. Three isothermal sections were determined at 1000, 850, and 700 °C.

Binary Systems

In the Co-Fe system [2002Ohn, Massalski2], a continuous face-centered cubic (fcc) solid solution denoted γ forms between fcc Fe and fcc Co. The γ → α (bcc) transformation temperature in Fe is initially raised by the addition of Co, reaching a maximum of 985 °C at 45 at.% Co. At 730 °C, the bcc phase of equiatomic composition orders to a *B*2 structure via a second-order transition. [2002Ohn] showed that the (α + γ) two-phase field extends below the temperature at which the bcc/*B*2 boundary meets the α/(α + γ) boundary. The more recent results of [2006Ust] do not agree with the above. The Co-Ga phase diagram [2005Oka, Massalski2] depicts two intermediate phases: β (29-64 at.% Ga; *B*2, CsCl-type cubic) and $CoGa_3$ (tetragonal). 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), βFe_3Ga ($D0_{19}$, Ni_3Sn-type hexagonal), αFe_3Ga ($L1_2$, $AuCu_3$-type cubic), βFe_6Ga_5 (Al_8Cr_5-type rhombohedral), αFe_6Ga_5 (Fe_6Ge_5-type monoclinic), Fe_3Ga_4 (monoclinic), and $FeGa_3$ ($CoGa_3$-type tetragonal).

Ternary Isothermal Sections

With starting metals of 99.9% Co, 99.9% Fe, and 99.9999% Ga, [2007Duc] prepared a diffusion couple of Fe and Co, which was annealed at 1000 °C for 4 h. Holes were then drilled in the diffusion zone for adding Ga chips. The triple diffusion couples were annealed at 1000, 850, and 700 °C for 4, 10, and 30 h, respectively. The phase equilibria were studied with optical and scanning electron microscopy and electron probe microanalysis. The order-disorder and magnetic transformation temperatures were determined by differential scanning calorimetry at a heating rate of 5 °C/min or by vibrating-sample magnetometer at a heating rate of 2 °C/min. The isothermal sections constructed by [2007Duc] at 1000, 850, and 700 °C are redrawn in Fig. 1-3 to agree with the accepted binary data. At 1000 °C (Fig. 1), along the Fe-Co side, a continuous fcc field is present. The (γ + bcc) field is very narrow, as compared to (γ + *B*2) field. The bcc → *B*2 transition is second-order in nature without an intervening two-phase region. At 850 °C (Fig. 2), the bcc phase has a wider range. At 700 °C (Fig. 3), the *B*2 phase orders to Heusler-type $L2_1$ phase with increasing Ga content. The magnetic transition is seen in the bcc, *B*2, and $L2_1$ phases. A continuous solid solution between $FeGa_3$ and $CoGa_3$ is indicated schematically in Fig. 3.

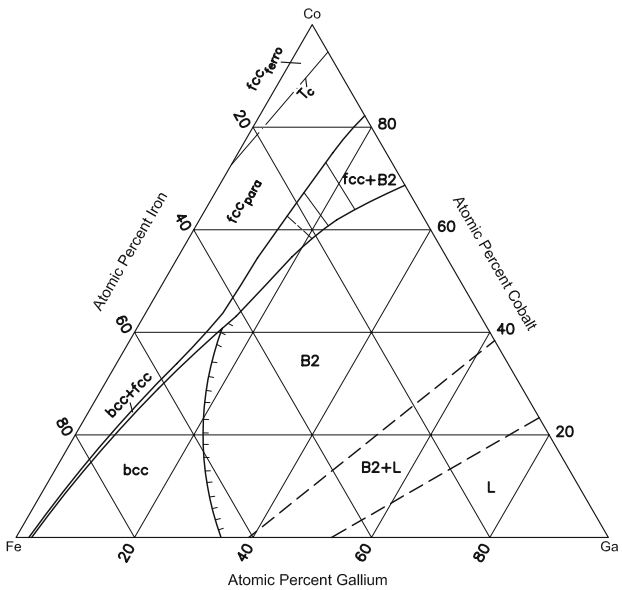

Fig. 1 Co-Fe-Ga isothermal section at 1000 °C [2007Duc]

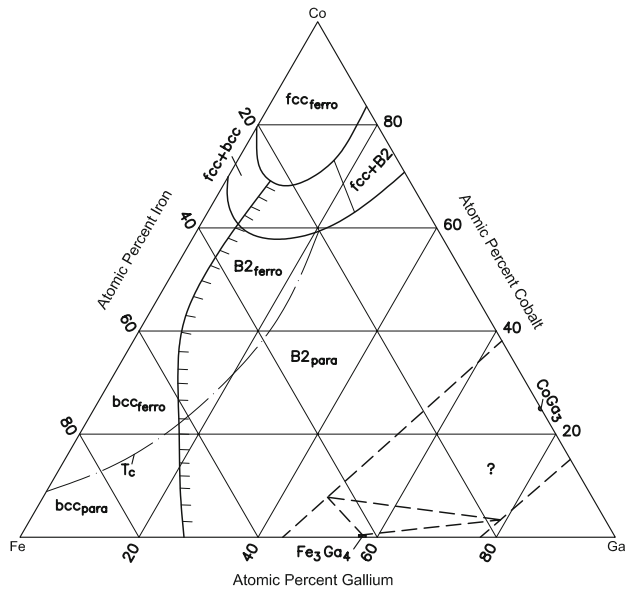

Fig. 2 Co-Fe-Ga isothermal section at 850 °C [2007Duc]

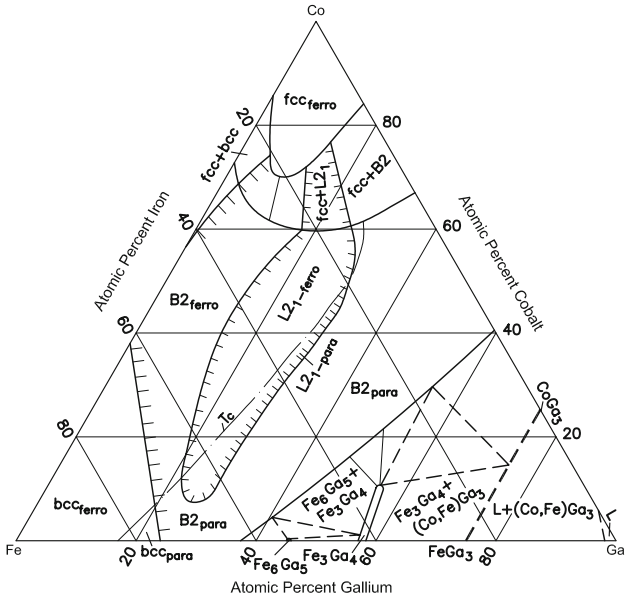

Fig. 3 Co-Fe-Ga isothermal section at 700 °C [2007Duc]

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