

Al-Fe-Ga (Aluminum-Iron-Gallium)

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Recently, [2008Zho] determined an isothermal section for Fe-rich alloys of this system at 650 °C and a vertical section along the Fe-Ga_{0.75}Al_{0.25} join.

Binary Systems

The Al-Fe phase diagram [Massalski2] depicts several intermediate phases. Apart from the high temperature phase Fe₄Al₅ (ϵ), there are three phases stable down to room temperature: FeAl₂ (triclinic), Fe₂Al₅ (70-73 at.% Al; orthorhombic), and FeAl₃ (Fe₄Al₁₃) (74.5-76.6 at.% Al; monoclinic). The Al-Ga phase diagram [Massalski2] is of the simple eutectic type, with the eutectic point at 97.9 at.% Ga and 26.6 °C. The Fe-Ga phase diagram [2004Oka, Massalski2] has the following intermediate phases: α' (B2, CsCl-type cubic), α'' (D0₃, BiF₃-type cubic), β Fe₃Ga (D0₁₉, Ni₃Sn-type hexagonal), α Fe₃Ga (L1₂, AuCu₃-type cubic), β Fe₆Ga₅ (Al₈Cr₅-type rhombohedral), α Fe₆Ga₅ (Fe₆Ge₅-type monoclinic), Fe₃Ga₄ (monoclinic), and FeGa₃ (CoGa₃-type tetragonal).

Ternary Phase Equilibria

With starting metals of 99.99% Al, 99.9% Fe and 99.99% Ga, [2008Zho] arc-melted 21 Fe-rich ternary

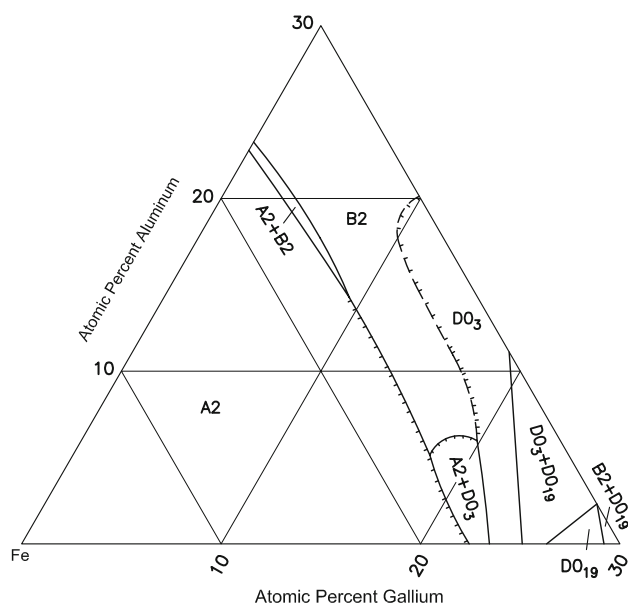


Fig. 1 Al-Fe-Ga isothermal section near Fe corner at 650 °C [2008Zho]

alloys. The alloys were given a final anneal at 650 °C for 120-480 h and quenched in water. The phase equilibria were studied with optical and scanning electron metallography, x-ray powder diffraction, energy dispersive x-ray spectroscopy, and differential thermal analysis. The isothermal section at 650 °C constructed by [2008Zho] is shown in Fig. 1. The $A2 \rightarrow B2$ transition is first-order at low Ga contents and becomes second-order, as more Ga substitutes for Al. The D0₁₉ phase field in Fe-Ga alloys becomes unstable with a few percent addition of Al. Figure 2 shows the vertical section proposed by [2008Zho] along the Fe-Ga_{0.75}Al_{0.25} join. At ≥ 20 mol.% of Ga_{0.75}Al_{0.25}, the $A2 + L1_2$ two-phase region is stable at lower temperatures. A eutectoid reaction $D0_3 \leftrightarrow A2 + L1_2$ is indicated by [2008Zho] at ~ 584 °C.

References

- 2004Oka: H. Okamoto, Fe-Ga (Iron-Gallium), *J. Phase Equilib. Diffus.*, 2004, **25**(1), p 100
2008Zho: Y. Zhou, B. Wang, S. Li, W. Huang, and S. Cao, Phase Diagram of the Iron-Rich Portion in the Iron-Gallium-Aluminum Ternary System, *Int. J. Mater. Res.*, 2008, **99**(3), p 251-256

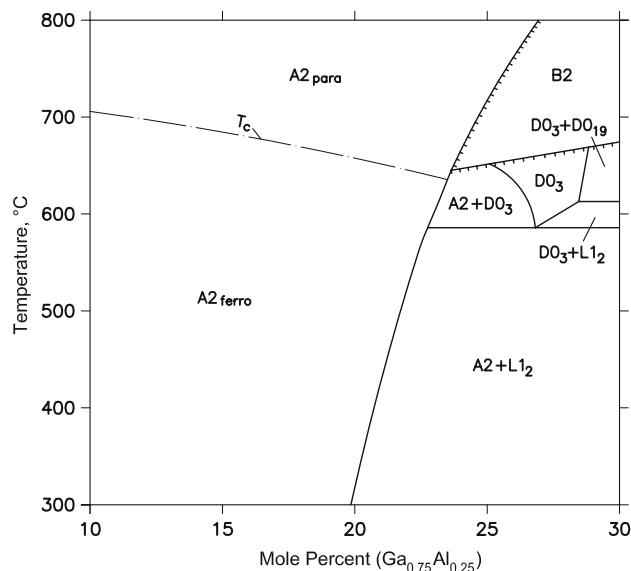


Fig. 2 Al-Fe-Ga vertical section along the Fe-Ga_{0.75}Al_{0.25} join [2008Zho]