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Cr-Dy-Fe (Chromium-Dysprosium-Iron)

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Recently, [2009Yao] determined an isothermal section for this system at 500 °C which depicts a ternary compound $DyFe_{10}Cr_2$ (τ).

Binary Systems

There are no intermediate phases in the Cr-Dy system [Massalski2]. The mutual solubility between Cr and Dy is small. In the Fe-Cr phase diagram [1993Itk], a gamma loop restricts the fcc region to about 14 at.% Cr. The bcc α phase is stable over a large region. The intermediate phase σ ($D8_b$-type tetragonal) forms from α at 820 °C around the mid-composition and decomposes eutectoidally at 545 °C to Fe-rich bcc (α) and Cr-rich bcc (α′) phases. The Fe-Dy phase diagram [Massalski2] depicts the following intermediate phases: $Fe_{17}Dy_2$ ($Ni_{17}Th_2$-type hexagonal), $Fe_{23}Dy_6$ ($D8_a$, $Mn_{23}Th_6$-type cubic), Fe_3Dy(Be_3Nb-type rhombohedral), and Fe_2Dy ($C15$, $MgCu_2$-type cubic).

Ternary Isothermal Section

Two ternary compounds are known in this system: $DyFe_{12-x}Cr_x$ ($1.6 \le x \le 3.0$), denoted τ here, has the $ThMn_{12}$-type tetragonal structure. $Dy_3Fe_{29-x}Cr_x$ ($0.6 \le x \le 4.0$) with the $Nd_3(Fe,Ti)_{29}$-type of monoclinic structure was found at 1000 °C, but it is not stable at 500 °C [2009Yao].

With starting metals of 99.9% Cr, 99.9% Dy, and 99.99% Fe, [2009Yao] arc-melted 140 alloys in Ar atm. The alloys were given a final anneal at 500 °C for 150 h and quenched in water. The phase equilibria were studied mainly with x-ray powder diffraction. The isothermal section at 500 °C constructed by [2009Yao] is shown in Fig. 1. The ternary phase τ is present. The Fe-Dy binary compounds $Fe_{17}Dy_2$, $Fe_{23}Dy_6$, Fe_3Dy, and Fe_2Dy dissolve up to 13, 6, 5, and 16 at.% Cr, respectively. The Fe-Cr σ phase is not stable at 500 °C.

References

1993Itk: V.P. Itkin, Cr-Fe (Chromium-Iron), *Phase Diagrams of Iron Alloys*, H. Okamoto, Ed., ASM International, Materials Park, OH, 1993, p 102-129

2009Yao: Q. Yao, H. Wang, Z. Liu, H. Zhou, and S. Pan, An Investigation of the Dy-Fe-Cr Phase Diagram: Phase Equilibria at 773 K, *J. Alloys Compd.*, 2009, **475**, p 286-288

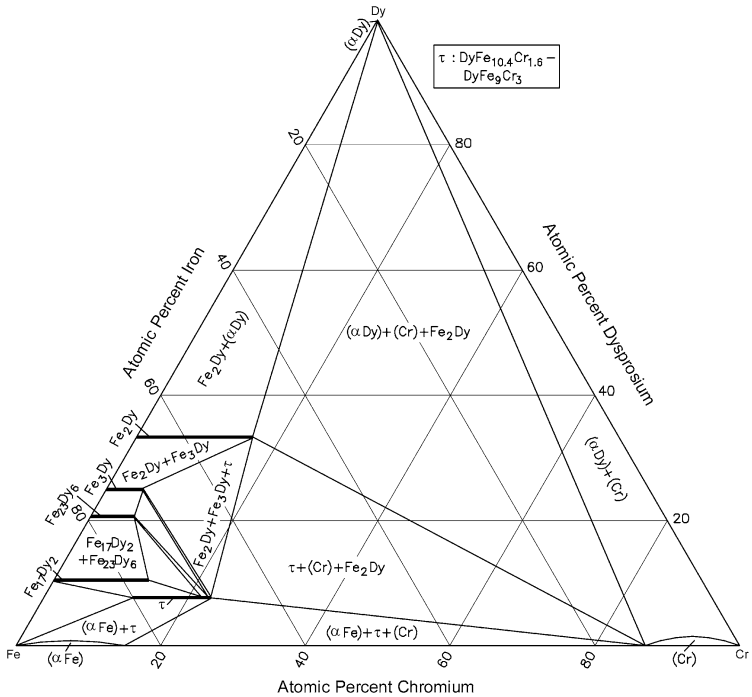

Fig. 1 Cr-Dy-Fe isothermal section at 500 °C [2009Yao]. Narrow two-phase regions are omitted