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Cr-Fe-Zn (Chromium-Iron-Zinc)

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Reviews of the phase equilibria at 450 and 460 °C of this ternary system were presented by [2003Rag1] and [2007Rag]. Very recently, [2008Ai] determined an isothermal section at 600 °C, which depicts a ternary compound at the composition $Fe_{18}Zn_{79}Cr_3$.

Binary Systems

In the Cr-Fe system [1993Itk], the intermediate phase σ ($D8_b$, σCrFe-type tetragonal) forms from the body-centered cubic (bcc) phase (αFe) at 820 °C and decomposes eutectoidally at 545 °C to Fe-rich and Cr-rich bcc phases. The partial phase diagram of the Cr-Zn system [1992Mos] depicts two intermediate phases: $CrZn_{17}$ (hexagonal) and $CrZn_{13}$ ($CoZn_{13}$-type monoclinic). In the Fe-Zn system [2003Rag2, 2005Nak], the intermediate phases are: Γ (Fe_3Zn_{10}; Cu_5Zn_8-type cubic), Γ_1 ($Fe_{11}Zn_{40}$; cubic, space group $F\bar{4}3m$, 408 atoms/cell), δ ($FeZn_{10}$; $FeZn_{10}$-type hexagonal), and ζ ($CoZn_{13}$-type monoclinic).

Ternary Isothermal Section

With starting metals of 99.99% purity, [2008Ai] melted powder mixtures of Zn-rich alloys in evacuated quartz tubes. In the case of Zn-lean alloys, Fe-Cr master alloys were arc-melted, crushed to powder, mixed with zinc and remelted in evacuated tubes. The final anneal at 600 °C was for 40 d, followed by quenching in water. The phase equilibria were characterized with diffusion couple experiments, x-ray powder diffraction, and a scanning electron microscope equipped with energy dispersive X-ray spectroscope. The isothermal section at 600 °C constructed by [2008Ai] is redrawn in Fig. 1 to agree with the accepted binary data. A ternary compound denoted P with the approximate composition $Fe_{18}Zn_{79}Cr_3$ was found by [2008Ai]. This composition is close to that of the Γ_1 phase, which is not stable at this temperature. The x-ray pattern of this compound was stated by [2008Ai] to be vastly different from that of Γ_1, but the structural details are not known. In Fig. 1, the small composition range of

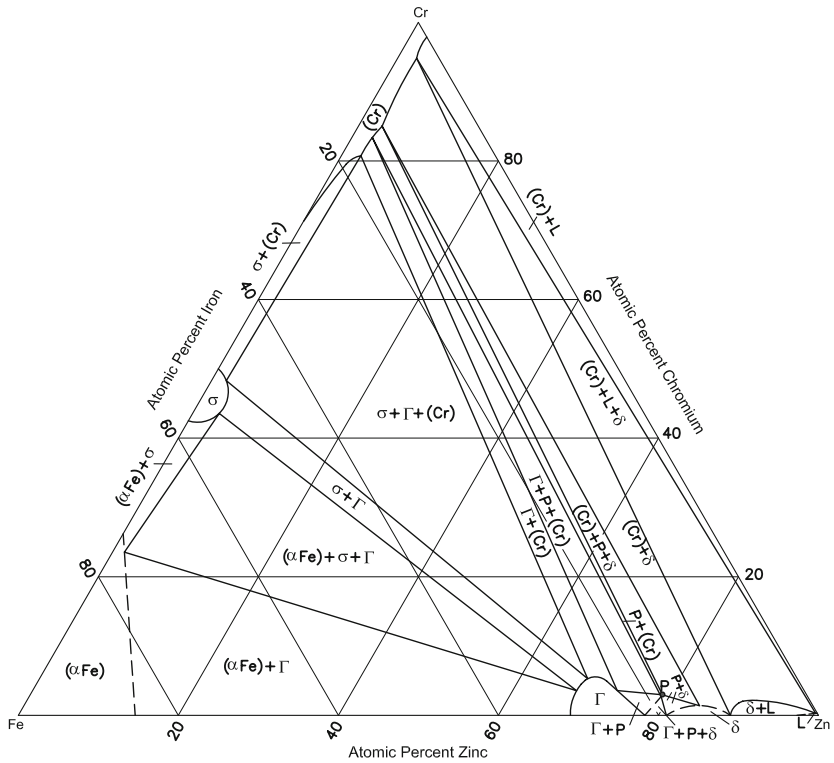

Fig. 1 Cr-Fe-Zn isothermal section at 600 °C [2008Ai]

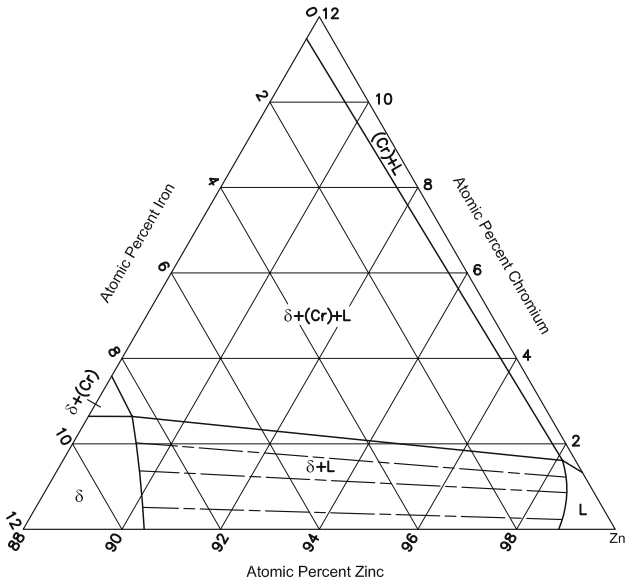

Fig. 2 Cr-Fe-Zn isothermal section at 600 °C near Zn corner, depicting tie-lines between δ and liquid [2008Ai]

P observed by [2008Ai] is neglected and the phase is shown at the fixed composition of $Fe_{18}Zn_{79}Cr_3$. At 600 °C, the solubility of Zn in (Cr) is 2.5 at.% and that of Cr in Γ, δ, and liquid is 5.4, 3.1, and 1.4 at.% respectively. The Cr-Zn binary compounds were not found at 600 °C. Figure 2 shows an enlarged view near the Zn corner at 600 °C, depicting the tie-lines between δ and liquid [2008Ai].

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