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

V. Raghavan

The review of this ternary system by [2003Rag] presented a metastable isothermal section at 460 °C from [2000Reu] and the liquid phase boundary near the Zn corner at 450 °C from [2002Tan]. Careful experimentation by [2005Tan] has since provided valuable data on the solubility of Fe and Cr in the Zn-rich liquid at temperatures between 470 and 430 °C.

Binary Systems

In the Cr-Fe system, the intermediate phase σ ($D8_b$-type tetragonal) forms from the body-centered cubic (bcc) phase α at 820 °C and decomposes eutectoidally at 545 °C to Fe-rich and Cr-rich bcc phases. A partial phase diagram of the Cr-Zn system for Zn-rich alloys [1992Mos] depicts two intermediate phases: $CrZn_{17}$ (hexagonal) and $CrZn_{13}$ (monoclinic, isostructural with ζ-$FeZn_{13}$). Recently, [2005Tan] made accurate measurements of the solubility of Cr in molten zinc. The solubility was found to be significantly smaller than found in several earlier investigations. Two linear regions were found in plots of ln [at.% Cr] versus 1/T(K). Between 560 and 464 °C, the solubility follows the relation: ln [at.% Cr] = 2.33 − 2.19 × $10^3/T$ (K). Between 464 and 420 °C, the solubility is given by: ln [at.% Cr] = 12.9 − 9.90 × $10^3/T$(K). The transition temperature of 464 °C coincides with the incongruent melting of $CrZn_{17}$. The Fe-Zn phase diagram exhibits a γ loop, extensive solubility of Zn in the body-centered cubic (bcc) Fe (α), and four intermediate phases: Fe_3Zn_{10} (denoted Γ; 68.5-82.5 at.% Zn, Cu_5Zn_8-type cubic), $Fe_{11}Zn_{40}$ (denoted Γ_1; 75-81 at.% Zn, cubic), $FeZn_{10}$ (denoted δ; 86.5-91.8 at.% Zn, hexagonal) and $FeZn_{13}$ (denoted ζ; 92.8-94 at.% Zn, $CoZn_{13}$-type monoclinic).

Ternary Isothermal Sections

On the basis of new experimental measurements, [2003Reu] modified the metastable isothermal section of [2000Reu]. The modified section is shown in Fig. 1. The ternary phase ζ′ reported earlier is not present. The continuous solid solution between the isostructural compounds $CrZn_{13}$ and $FeZn_{13}$ is interrupted by $CrZn_{17}$ extending into the ternary region.

Starting with high purity metals, [2005Tan] equilibrated molten alloys in a ceramic crucible between 470 and 430 °C at ~10 °C intervals. Samples were withdrawn through a glass tube from two locations: the middle and the bottom of the bath. The analyzed compositions of the liquid and the intermetallic phases were listed. The isothermal section at the Zn corner at 450 °C [2005Tan] is redrawn in Fig. 2. With increasing Cr content, the solubility of Fe in the melt decreases from ~0.03 wt.% at 0% Cr to ~0.02 wt.% at the three-phase equilibrium. Thereafter, with increasing Cr, the solubility of Fe decreases more rapidly in the region of the two-phase equilibrium of (L + $CrZn_{17}$). The solubility of Cr in pure liquid Zn is ~0.35 wt.%, which is lower than the previous estimates.

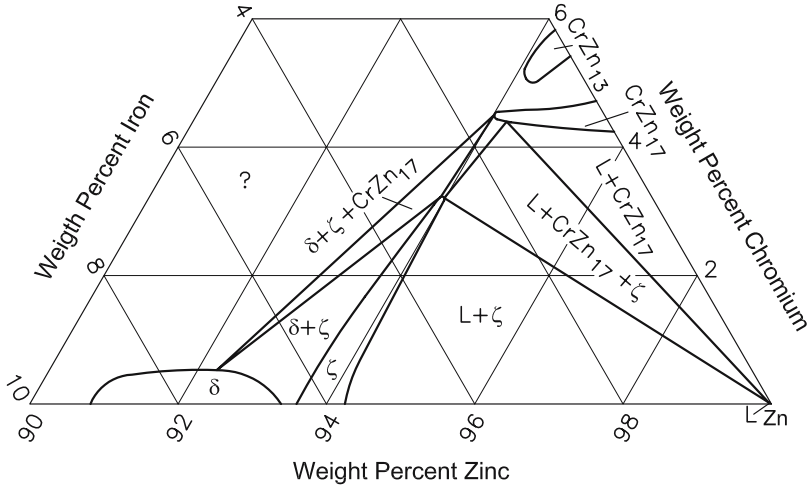

Fig. 1 Cr-Fe-Zn isothermal section at 460 °C [2003Reu]

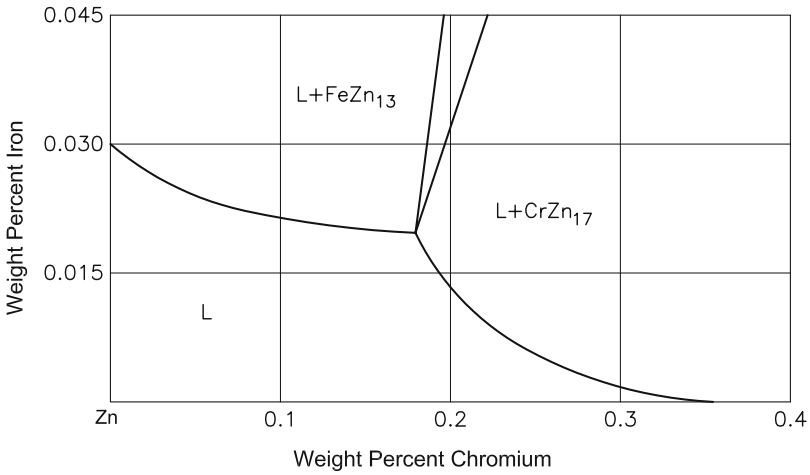

Fig. 2 Cr-Fe-Zn liquid phase boundary near the Zn corner at 450 °C [2005Tan]

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