JPEDAV (2004) 25:544
DOI: 10.1361/15477020421160
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Cr-Cu-Fe (Chromium-Copper-Iron)

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The dissolved impurities in Cu have a significant influence on its mechanical and electrical properties. The effect of Fe on the solubility of Cr in Cu was determined recently by [2001Fer]. The previous review of this system by [1992Rag] presented two vertical sections for Fe-rich alloys. An update by [2002Rag] gave an isothermal section at 1200 °C.

Binary Systems

The Cr-Cu system [2001Oka] is a simple eutectic system with the eutectic temperature just below the melting point of Cu. The Cr-Fe phase diagram was reviewed by [1993Itk]. Here, a gamma loop restricts the face-centered-cubic (fcc) phase γ to about 12 at.% (11 wt.%) Cr. The body-centered-cubic (bcc) phase α is stable over a large region. The intermediate phase σ ($D8_b$, tetragonal) forms from α at 820 °C around the midcomposition and decomposes eutectoidally at 545 °C to Fe-rich and Cr-rich bcc phases. The Cu-Fe phase diagram [Massalski2] has no intermediate phases. A metastable liquid miscibility gap is known in this system.

Solubility of Cr and Fe in Cu

[2001Fer] measured the solubility limit of Cr and Fe in Cu at 1050 °C. Three ternary alloys containing 0.7 wt.% Cr and 0.3-2.0 wt.% Fe were solution treated at 1050 °C for 3 h and quenched in water. The composition was measured by the wavelength dispersive spectroscopy (WDS). The isothermal section at 1050 °C constructed by [2001Fer] at the Cu corner is shown in Fig. 1. The addition of Fe to Cu decreases the solubility of Cr. The solubilities of Cr in the Cr-Cu binary and of Fe in Cu-Fe binary seen in Fig. 1 are in satisfactory agreement with the binary data.

[2001Fer] also measured the solubility limits at lower temperatures down to 500 °C, using the resistivity technique. Twelve more alloys with lower solute concentrations were included in the resistivity experiments. After the initial solution treatment, the alloys were aged for 3 h at lower temperatures. The solubility limit was identified by the decrease in the electrical resistivity with the onset of precipitation from the supersaturated solution. At lower temperatures, the solubility limits are lower. At 1050 °C, where

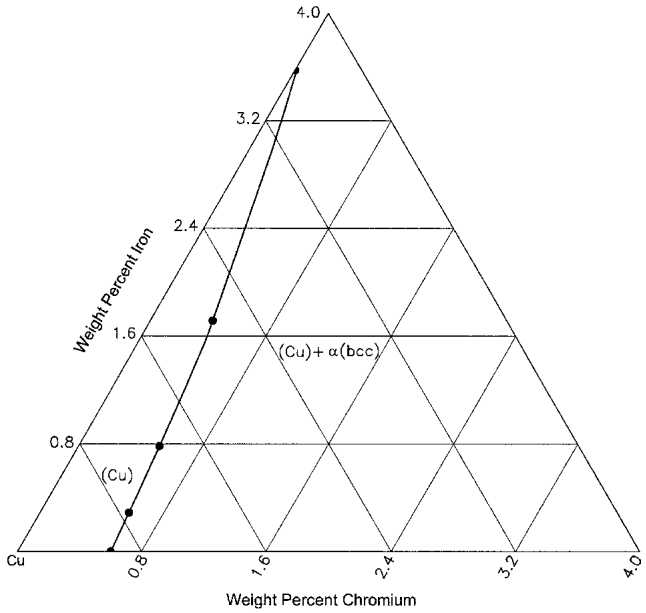

Fig. 1 Cr-Cu-Fe solubility limit of Fe and Cr in Cu at 1050 °C [2001Fer]

results were obtained from both WDS and electrical resistivity measurements, the solubility limit curve from electrical resistivity measurements were significantly closer to the Cu corner, as compared with the curve from WDS measurements. This difference was attributed by [2001Fer] to "the unavoidable precipitation during quenching."

References

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