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Cu-Fe-Si (Copper-Iron-Silicon)

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The pre-1979 experimental results of this ternary system were reviewed by [1979Cha]. [1992Rag] reviewed the later publications, presenting a liquidus projection for the Si-lean region, two isothermal sections at 875 and 500 °C, and a reaction scheme. Three recent publications, which reported new experimental results, are: [1997Oht] (isothermal sections at 1300, 1200, and 1100 °C), [1999Hin] (isothermal sections at 1450, 1350, and 1250 °C), and [2002Wan] (isothermal sections at 1000, 900, and 800 °C). Both [1997Oht] and [2002Wan] presented computed sections as well. These results were reviewed in an update by [2002Rag]. A new thermodynamic assessment of this ternary system was carried out by [2003Mie]; this is reviewed in this update.

Binary Systems

There are no intermediate phases in the Cu-Fe system. A metastable liquid miscibility gap is known in this system. In the Cu-Si phase diagram [Massalski2, 2003Mie], the liquidus temperature on the Si side drops from 1414 to 802 °C, where a eutectic reaction yields (Si) and Cu_3Si (or $Cu_{19}Si_6$) (rhombohedral, denoted η). At the Cu-rich end, a number of other intermediate phases form below 900 °C: $Cu_{15}Si_4$ (cubic, denoted ε), $Cu_{33}Si_7$ (tetragonal, denoted δ), $Cu_{56}Si_{11}$ (βMn-type cubic, denoted γ), β (bcc, 82.8-85.8 at.% Cu), and κ (cph, 85.5-89 at.% Cu). In the Fe-Si system [Massalski2], the Fe-based face-centered cubic phase γ is enclosed by a loop. The intermediate phases are: α_2 ($B2$, CsCl-type cubic), α_1 ($D0_3$, BiF_3-type cubic), Fe_2Si (stable between 1212 and 1040 °C; hexagonal), Fe_5Si_3 ($D8_8$, Mn_5Si_3-type hexagonal), FeSi ($B20$-type cubic), $\beta FeSi_2$ (tetragonal), and $\alpha FeSi_2$ (orthorhombic). Computed phase diagrams for the above binary systems were given by [2003Mie].

Thermodynamic Assessment

[2003Mie] modeled the liquid, fcc, bcc, and cph phases as disordered substitutional solutions. The Fe-Si compounds Fe_2Si, Fe_5Si_3 and FeSi, and the Cu-Si compounds η, ε, δ, and γ were treated as stoichiometric compounds. New phase diagram data from [1997Oht], [1999Hin], and [2002Wan] and the data from a vertical section at 10 mass% Fe from [1953Vog] were used in the optimization. No results on the thermodynamic properties were used. All computed results were for Si-lean compositions. The computed liquidus projection was not compared with experimental data. Computed isothermal sections at 1450, 1350, 1250, 1100, 1000, and 900 °C were compared with the experimental results of [1997Oht], [1999Hin], and [2002Wan] and the agreement was found to be satisfactory. Here, the computed isothermal section at 1000 °C and the computed vertical

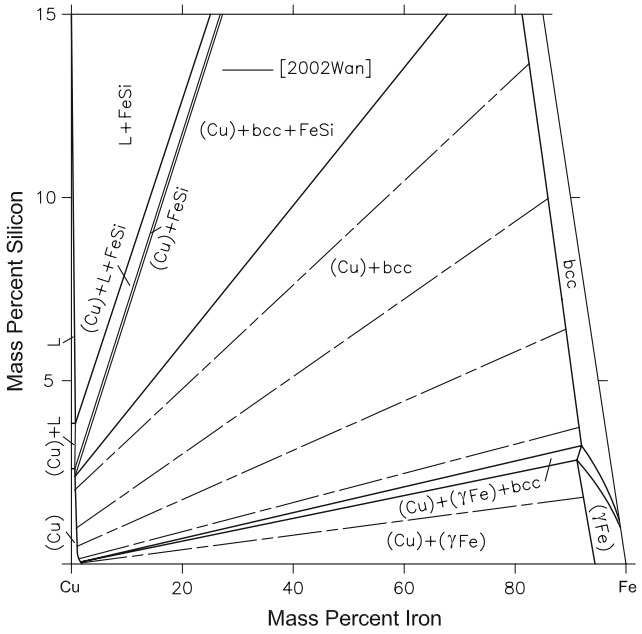

Fig. 1 Cu-Fe-Si computed isothermal section at 1000 °C [2003Mie]

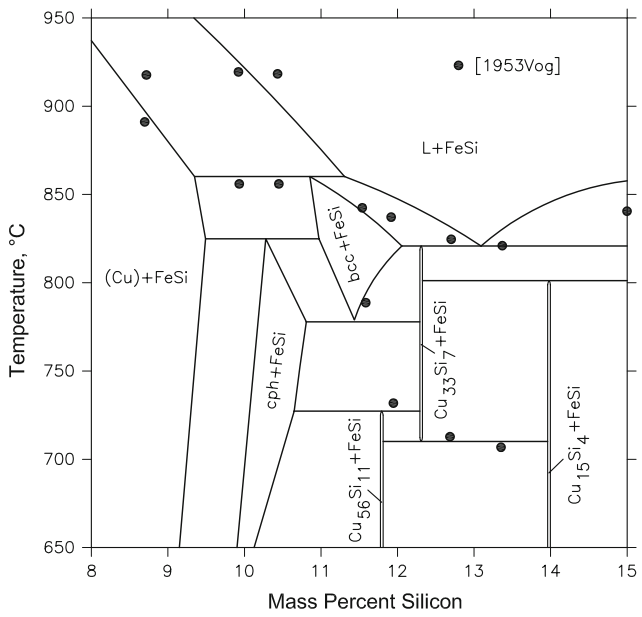

Fig. 2 Cu-Fe-Si computed vertical section at 10 mass% Fe [2003Mie]

section at 10 mass% Fe are shown in Fig. 1 and 2 respectively. The agreement with the experimental data was found to be satisfactory.

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