JPEDAV (2009) 30:384–385
DOI: 10.1007/s11669-009-9548-4
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Cu-Fe-Sn (Copper-Iron-Tin)

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The early review of this system by [1992Rag] presented two isothermal sections, at 1200 °C for Fe-rich alloys from [1962Mel] and at ~600 °C for the entire composition range from [1987Zho]. Subsequently, [1997Oht] determined the tie-lines between the Cu-Sn rich liquid and the Fe rich solid phases at 1300, 1200 and 1100 °C and computed an isothermal section at 1200 °C, which was reviewed by [2002Rag]. Recently, [2008Mie] computed the phase equilibria of this system, giving more weightage to Fe-rich alloys in the optimization.

Binary Systems

There are no intermediate phases in the Cu-Fe system. A metastable liquid miscibility gap has been experimentally measured in this system. The Cu-Sn phase diagram [Massalski2] depicts the following intermediate phases: β (13.1-16.5 at.% Sn; bcc), γ (15.5-27.5 at.% Sn; $D0_3$, BiF_3-type cubic), δ ($Cu_{41}Sn_{11}$; cubic, space group $F\bar{4}3m$), ζ ($Cu_{10}Sn_3$; high temperature phase, hexagonal, space group $P6_3$), ε (Cu_3Sn; orthorhombic, space group $Cmcm$), and η (43.5-44.5 at.% Sn; stable below 415 °C with two crystal modifications). The Fe-Sn system has the following intermediate phases: Fe_5Sn_3 ($B8_2$, Ni_2In-type hexagonal), Fe_3Sn_2 (rhombohedral), FeSn ($B35$, CoSn-type hexagonal) and $FeSn_2$ ($C16$, $CuAl_2$-type tetragonal). Computed phase diagrams of the above binary systems were given by [2008Mie].

Ternary Phases

A ternary compound Cu_2FeSn (τ) is known in this system, with cph and BiF_3-type cubic modifications [1992Rag]. The structural details of these were listed by [Pearson3]. The transition temperature was determined as 610 °C by [1987Zho], who suggested an orthorhombic symmetry for the low temperature form present at 600 °C. [2008Mie], on the other hand, ignored this compound, stating that "no ternary compounds have been reported".

Computed Ternary Phase Equilibria

In the thermodynamic description, [2008Mie] modeled the liquid, face centered cubic (fcc), body centered cubic (bcc) and the cubic γ phase of the Cu-Sn binary system as substitutional solutions. Ternary interaction parameters were introduced for the liquid, fcc and bcc phases. It is doubtful whether a single lattice description is applicable to the γ phase, which is reported to be of the BiF_3-type of cubic structure with a homogeneity range. The other binary compounds were treated as stoichiometric compounds, with nil solubility of the third component. Experimental data on phase equilibria from [1962Mel], [1966Sal] and [1997Oht] and on thermodynamic properties from [1981Yam] were used in the optimization. The optimized interaction

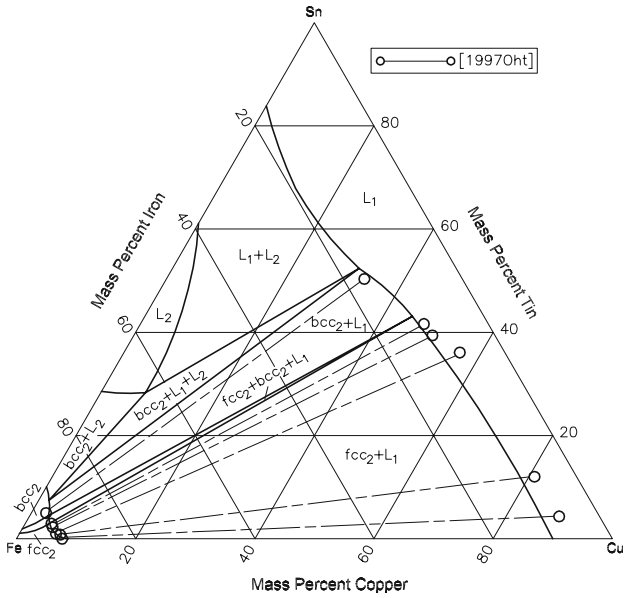

Fig. 1 Cu-Fe-Sn computed isothermal section at 1300 °C [2008Mie]

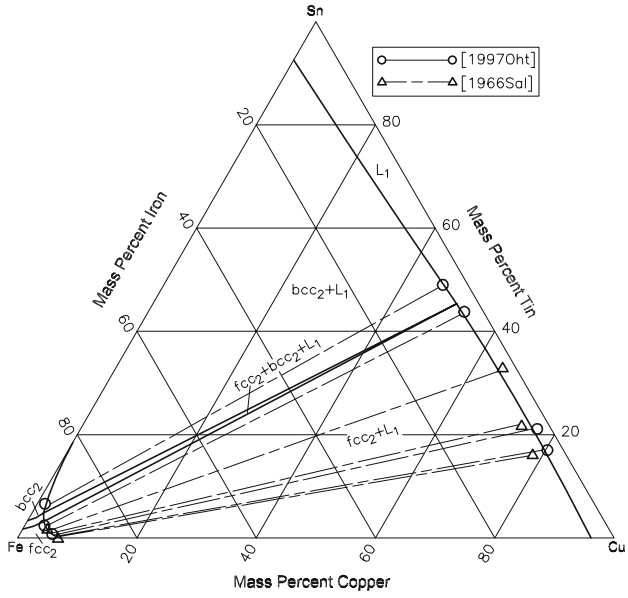

Fig. 2 Cu-Fe-Sn computed isothermal section at 1100 °C [2008Mie]

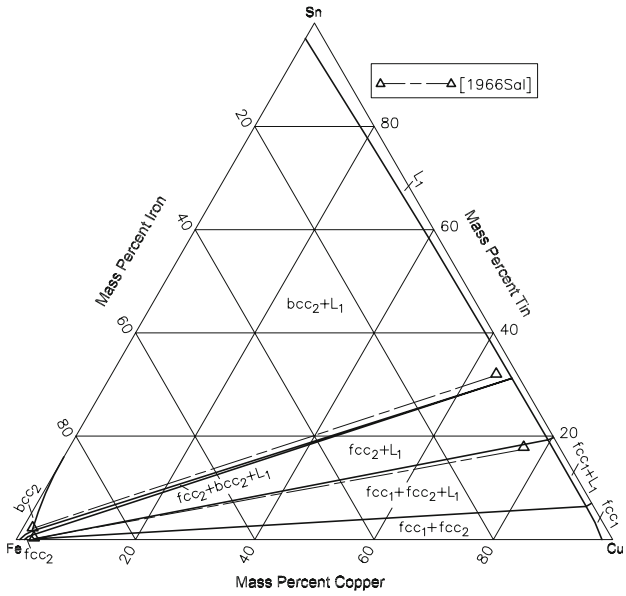

Fig. 3 Cu-Fe-Sn computed isothermal section at 900 °C [2008Mie]

parameters along with those adopted from the binary descriptions in the literature were listed.

A liquidus projection and seven isothermal sections at 1300, 1200, 1100, 900, 800, 700 and 550 °C were computed. Three isothermal sections at 1300, 1100 and 900 °C, where comparisons were made with experimental data, are shown in Fig. 1-3. The agreement is satisfactory. The isothermal section at 1200 °C was earlier computed and compared with experimental data by [1997Oht].

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