JPEDAV (2008) 29:533–534
DOI: 10.1007/s11669-008-9401-1
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As-C-Cu-Fe (Arsenic-Carbon-Copper-Iron)

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Recently, [2004Voi] determined the liquid miscibility gap and the distribution of As and C between the Fe-rich and Cu-rich liquids at 1200 °C in C-saturated melts of this quaternary system.

Lower Order Systems

No phase diagram is known for the As-C system. There are a number of intermediate phases in the As-Cu system. At the temperature of interest here (1200 °C), only a liquid phase is stable over the entire composition range. In the As-Fe system, three compounds are known: As_2Fe (marcasite-type orthorhombic), AsFe (MnP-type orthorhombic), and $AsFe_2$ (Cu_2Sb-type tetragonal). The mutual solubility between C and Cu is negligible. In the C-Fe system, the C content at saturation in Fe melts increases from 17.1 at.% at 1152 °C to ~21 at.% at 1600 °C. There are no intermediate phases in the Cu-Fe system. A metastable liquid miscibility gap is known in this system. The known phase diagrams of the above systems are given by [Massalski2].

The As-C-Cu system does not appear to have been investigated. The limited data on the liquidus surface in Fe-rich alloys of the As-C-Fe system and the solubility of C in As-Fe melts were reviewed by [1992Rag1]. [2004Voi] determined an isothermal section at 1200 °C for this system, which is redrawn in Fig. 1 to agree with the accepted binary data. The As-Cu-Fe system reviewed by [1992Rag2] presented a schematic liquidus surface and an isothermal section at ~25 °C. An isothermal section at 1150 °C for this system given by [2004Voi] depicts a miscibility gap between Fe-rich

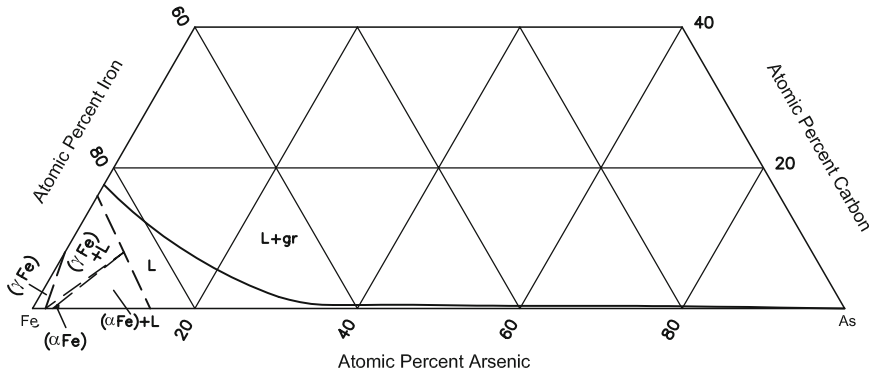

Fig. 1 As-Cu-Fe isothermal section at 1200 °C [2004Voi]

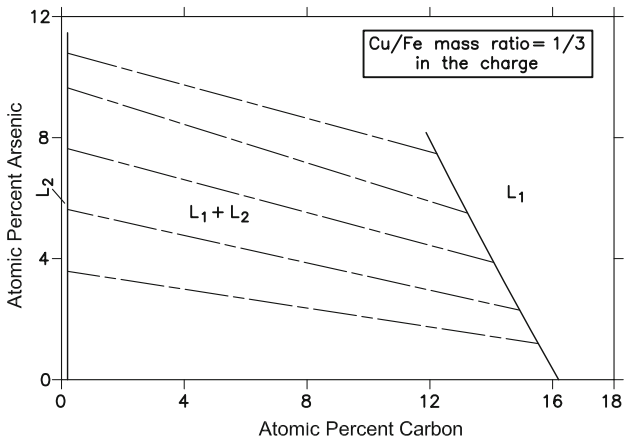

Fig. 2 As-C-Cu-Fe tie-lines between C-saturated Fe-rich liquid L_1 and Cu-rich liquid L_2 at 1200 °C [2004Voi]

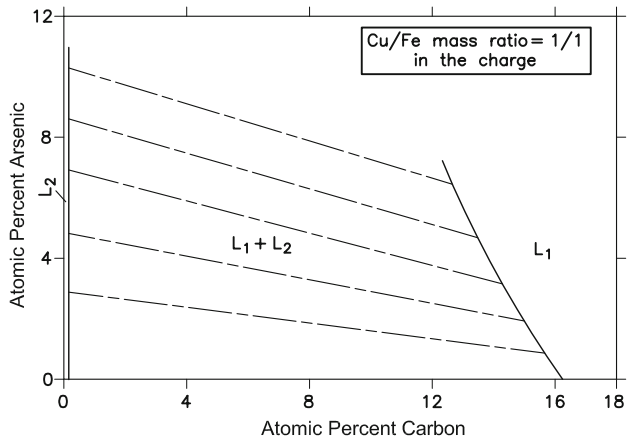

Fig. 3 As-C-Cu-Fe tie-lines between C-saturated Fe-rich liquid L_1 and Cu-rich liquid L_2 at 1200 °C [2004Voi]

and Cu-rich liquids. The update on the C-Cu-Fe system by [2002Rag] presented a liquidus projection for the Fe-rich region.

Quaternary Phase Equilibria

[2004Voi] mixed pure elements with a constant mass ratios of Cu/Fe = 1/3, 1/1, and 3/1 respectively, with a graphite rod for achieving C-saturation and varying As content. The samples were sealed in quartz ampules, melted and kept at 1200 °C for 12 h, before quenching in water. The presence of two clearly-separated liquids was confirmed by metallography and electron probe microanalysis (EPMA). The composition was determined by combustion infrared spectrometry for carbon and by EPMA and inductively coupled plasma spectrometry (ICP) for the other elements. The measured compositions of the coexisting liquids were listed. With Cu/Fe mass ratio of 1/3 in the charge, the As, C, and Fe contents of the Cu-rich liquid were up to 12.6, 0.04, and 9.72 mass% respectively. The As, C, and Cu contents in the Fe-rich liquid were up to 10.6, 3.98, and 6.76 mass% respectively. With other Cu/Fe mass ratios of 1/1 and 3/1 in the charge, the distribution of elements between the two immiscible liquids was similar to the above. The observed variation in the As and C contents of the co-existing Fe-rich and Cu-rich liquids at 1200 °C is shown in Fig. 2-4 [2004Voi]. The liquid miscibility gap at C saturation is plotted in Fig. 5 as a function of As, Cu, and (Fe + C).

The effect of minor additions of Ag, Co, Ni, Pt, and S at 1200 °C was also studied by [2004Voi]. It was found that Co segregated in the Fe-rich liquid phase, Ag in the Cu-rich phase, and the other additions were more or less evenly distributed between the two liquids.

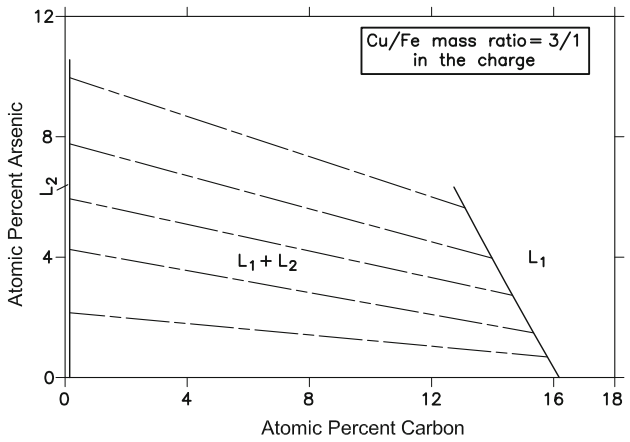

Fig. 4 As-C-Cu-Fe tie-lines between C-saturated Fe-rich liquid L_1 and Cu-rich liquid L_2 at 1200 °C [2004Voi]

References

1992Rag1: V. Raghavan, The As-C-Fe (Arsenic-Carbon-Iron) System, in *Phase Diagrams of Ternary Iron Alloys, Part 6A*, Indian Institute of Metals, Calcutta, 1992, p 229-232

1992Rag2: V. Raghavan, The As-Cu-Fe (Arsenic-Copper-Iron) System, in *Phase Diagrams of Ternary Iron Alloys, Part 6A*, Indian Institute of Metals, Calcutta, 1992, p 244-249

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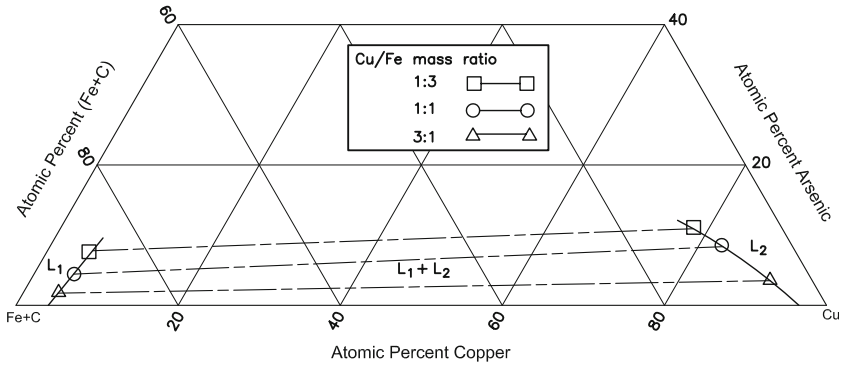

Fig. 5 As-C-Cu-Fe partial isothermal section at 1200 °C and at C-saturation [2004Voi]