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Al-Cu-Si (Aluminum-Copper-Silicon)

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The compilation by [1995Vil] of the experimental data on this ternary system includes a liquidus projection, partial isothermal sections at 955, 850, 750, 650, 600, 500, 400 and 25 °C and twenty vertical sections, mainly from the studies of [1934Mat], [1948Wil], and [1953Phi]. Recently, [2005Pan] made a thermodynamic assessment of this system and presented a computed liquidus projection and several computed vertical sections for Al-rich alloys.

Binary Systems

The Al-Cu phase diagram [1998Sau, Massalski2] depicts a number of intermediate phases: $CuAl_2$ (*C*16-type tetragonal, denoted θ), CuAl (monoclinic, η), Cu_5Al_4(LT) (monoclinic, ζ), ε_2 (NiAs-type hexagonal), ε_1(bcc), Cu_3Al_2 (rhombohedral, *δ*), Cu_9Al_4(HT) (γ_0), Cu_9Al_4(LT) ($D8_3$-type cubic, γ_1), and Cu_3Al (bcc, β). In the above, HT = high-temperature and LT = low-temperature. The Al-Si phase diagram [1998Gro] is a simple eutectic system with the eutectic at 577 °C and 12.2 at.% Si. The Cu-Si phase diagram [2000Yan, Massalski2] depicts the following intermediate phases: Cu_3Si (rhombohedral, denoted η), $Cu_{15}Si_4$ (cubic, denoted ε), Cu_4Si (tetragonal, denoted *δ*), Cu_5Si (βMn-type cubic, denoted γ), β (high temperature bcc phase), and Cu_7Si (cph, denoted κ).

Computed Ternary Phase Equilibria

The experimental data reviewed by [1992Luk] were used as the base by [2005Pan]. These included results from [1928Gwy], [1934Mat], [1935His], [1953Phi], an [1990Kuz]. The thermochemical data used in the optimization were those of [1985Far] on the heat of melting of the Al-rich eutectic, and of [1997Bel] and [2000Wit] on the heat of mixing of liquid alloys at 1472 °C and 1302 °C respectively. More recently, new results on the solubility of Al and Cu in solid Si in equilibrium with liquid alloys were reported by [2005Yos]. [2005Pan] used the binary descriptions of [1998Sau] (Al-Cu), [1998Gro] (Al-Si) and [2000Yan] (Cu-Si). Ternary interaction parameters for the liquid phase were optimized. The liquidus projection for Al-rich alloys computed by [2005Pan] is shown in Fig. 1. Two transition reactions U_1 and U_2 and the ternary eutectic reaction E occur near the Al corner. Five vertical sections computed 1, 5, and 10 mass % Si, at 10 mass % Cu, and at 80 mass % Al respectively are compared with the experimental data as indicated in Fig. 2-6 [2005Pan]. The agreement is good in all cases. The invariant horizontals

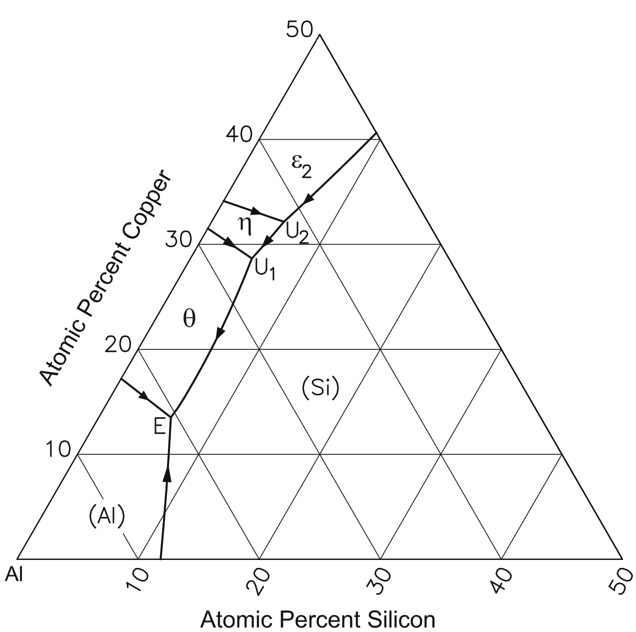

Fig. 1 Al-Cu-Si computed liquidus projection [2005Pan]

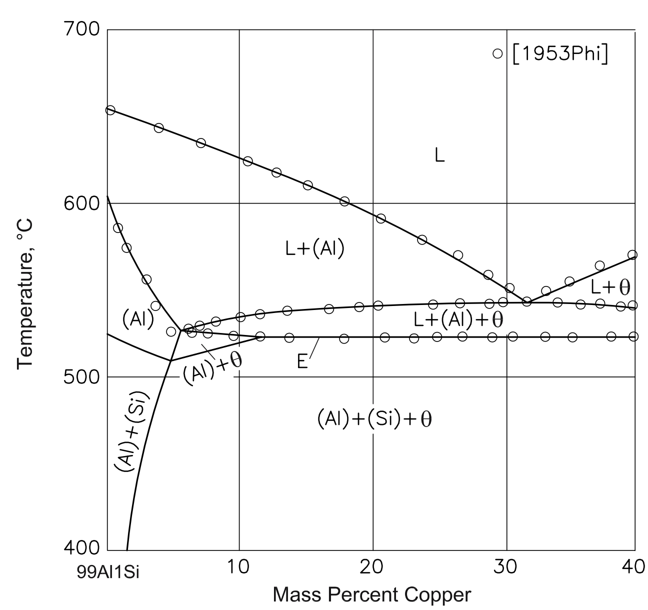

Fig. 2 Al-Cu-Si computed vertical section at 1 mass % Si [2005Pan]

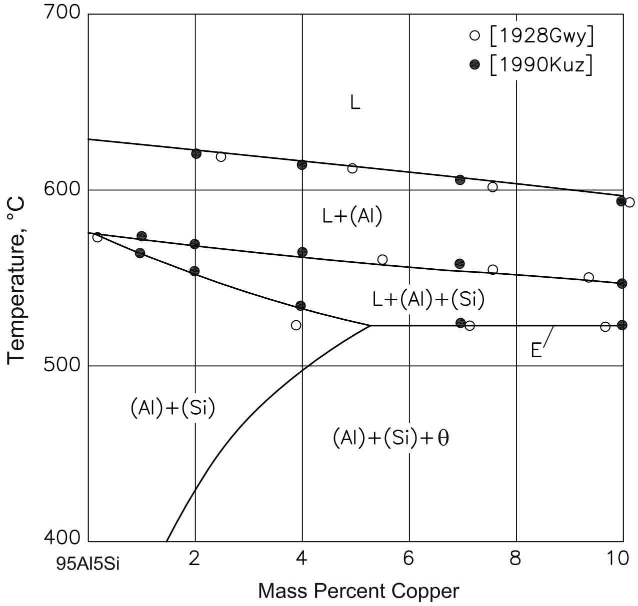

Fig. 3 Al-Cu-Si computed vertical section at 5 mass % Si [2005Pan]

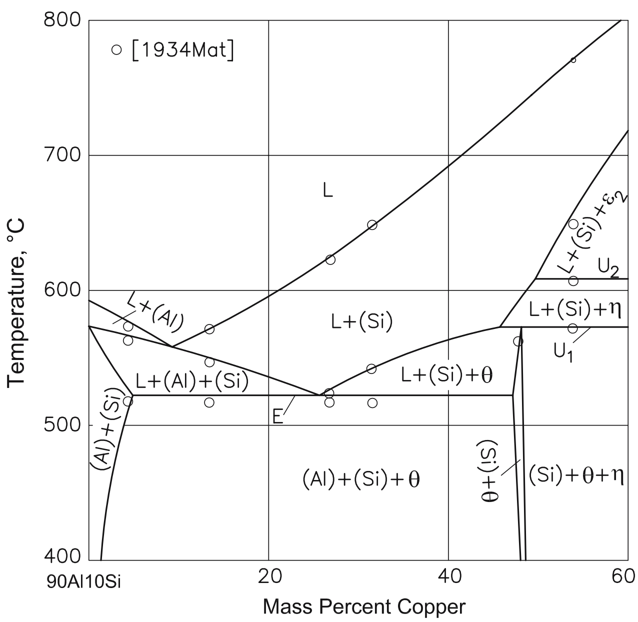

Fig. 4 Al-Cu-Si computed vertical section at 10 mass % Si [2005Pan]

corresponding to E in Fig. 1 is seen in all sections (Fig. 2-6). In Fig. 4, the invariant horizontals corresponding to U_1 and U_2 are also seen.

A limited number of experimental results by [2005Pan] on the solidification behavior of Al-7 mass % Si-3.5 mass % Cu alloy were compared with the computed solidification path under equilibrium conditions and with the Scheil solidification model (infinite rate of diffusion in liquid and nil diffusion in solid).

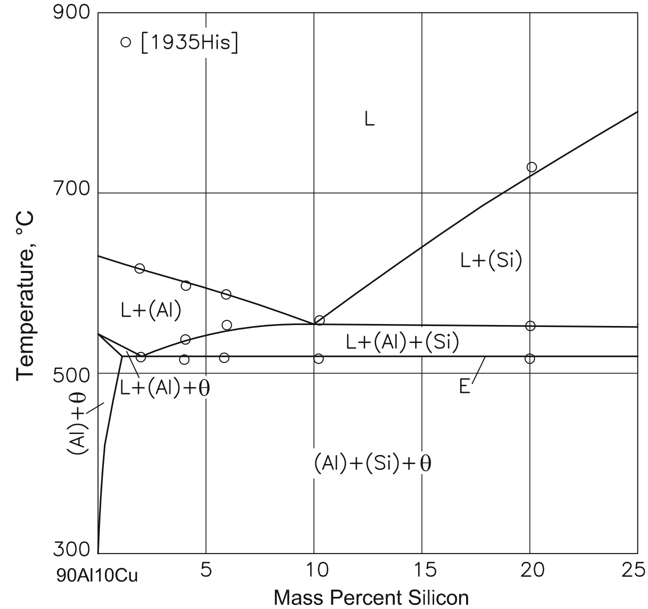

Fig. 5 Al-Cu-Si computed vertical section at 10 mass % Cu [2005Pan]

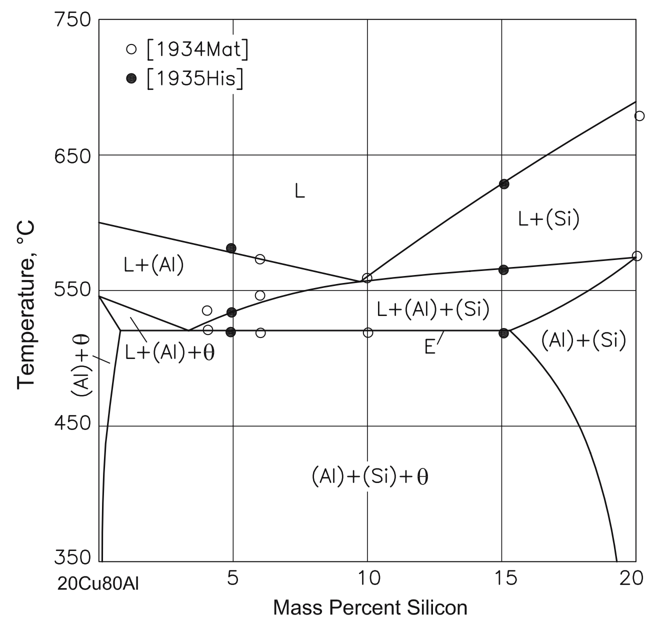

Fig. 6 Al-Cu-Si computed vertical section at 80 mass % Al [2005Pan]

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