Silver – Bismuth – Copper

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Introduction

The first data on the Ag-Bi-Cu system were reported by [1951Ava], who considered microstructure of alloys near the binary Ag-Cu eutectic depending on the cooling rate. [1976Zan] reported results of rapid quench-cooling experiments in the Ag rich part of the system. A eutectic reaction was found to exist at 240 ± 5°C, but the phases in equilibrium were not specified. This work was reviewed by [1980Hen] and [1988Hen]. [1988Liu, 1989Liu] investigated the entire ternary system in 12 vertical sections by thermoanalysis (DTA) in an atmosphere of dry nitrogen. They found that the ternary Ag-Bi-Cu system is a simple eutectic one with the invariant reaction at 258°C. [1998Shu] has calculated the liquidus surface using a model of ideal solution of self-associates and compared the result with that measured by [1989Liu]. [2004Doi] has presented the primary crystallization surfaces and liquidus isotherms calculated using Calphad method and the thermodynamic parameters for the three binary systems. A good agreement was found between the results of calculation and the experimental data by [1989Liu].

Binary Systems

The binary systems Ag-Cu and Bi-Cu are accepted from the MSIT Evaluation Program [2002Rom] and [2002Cac], respectively. The Ag-Bi phase diagram is accepted from [Mas2].

Solid Phases

No ternary phases were found in this system. The crystallographic data of the phases in the Ag-Cu-Bi system and their ranges of stability are listed in Table 1.

Invariant Equilibria

One invariant eutectic reaction: L ⇌ (Ag) + (Cu) + (Bi) at 258°C exists in the ternary system [1989Liu]. The composition of the liquid phase is given in Table 2.

Liquidus Surface

The liquidus surface after [1989Liu] is given in Fig. 1.

Notes on Materials Properties and Applications

The Ag-Bi-Cu system is a part of the Ag-Bi-Cu-Sn system which has been enumerated as a strong potential candidate alloy for a lead-free solder [2004Doi].

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Table 1: Crystallographic Data of Solid Phases

Phase/ Temperature Range [°C]	Pearson Symbol/ Space Group/ Prototype	Lattice Parameters [pm]	Comments/References
(Ag) < 961.93	*cF*4 $Fm\bar{3}m$ Cu	a = 408.57	pure Ag at 25°C [Mas2] dissolves 14 at.% Cu [Mas2, 2002Rom]
(Cu) < 1084.62	*cF*4 $Fm\bar{3}m$ Cu	a = 361.46 a = 363.7	dissolves 5 at.% Ag [Mas2, 2002Rom], 0.0193 at.% Bi [Mas2, 2002Cac] at 25°C [Mas2] melting point [1994Sub, 2002Rom] pure Cu at 19°C [Mas2, 2002Rom]
(Bi) < 271.442	*hR*6 $R\bar{3}m$ αAs	a = 454.613 c = 1186.152	at 31°C [V-C2, 2002Cac]

Table 2: Invariant Equilibria

Reaction	T [°C]	Type	Phase	Composition (at.%)		
				Ag	Cu	Bi
L ⇌ (Ag) + (Cu) + (Bi)	258	E	L	5.0	0.5	94.5

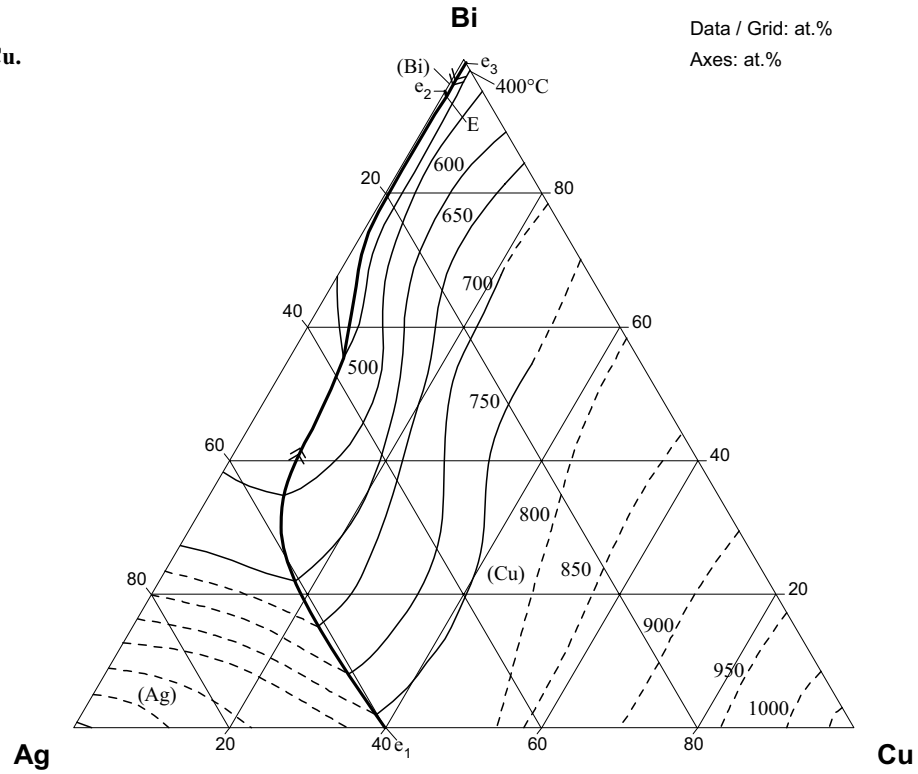

Fig. 1: Ag-Bi-Cu. Liquidus surface projection