Cu-Ag binary system revised: wettability, surface composition, thermodynamics of phase boundaries

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Interfacial thermodynamics and capillary phenomena in binary Ag-Cu system are of special interest from both practical and theoretical point of view. On the one hand this system is a base for lead free solders in modern micro- and nanotechnologies. On the other hand due to the absence of intermetallic compounds in the Ag-Cu system and low affinity of both components to oxygen it provides a good model for studying the influence of the second component on the interfacial thermodynamics. It has been recently confirmed that the surface tension of liquid Ag-Cu alloy is well described by the Buttler equation [1] and there is noticeable enrichment of the alloy surface with silver. Similar trend was observed for the single phase solid solution of Ag in Cu: the solid-gas surface energy decreases with the increase of Ag content [2] and enrichment of the alloy surface with Ag was detected by AES [3].

The aim of the present study is to analyze the surface composition and thermodynamics of the single phase solid solution of Cu in Ag. The surface tension of solid Ag–xCu alloys, where x varies from 0.41 to 7.95 at. %, was measured by zero-creep method. Growth of the surface tension with Cu content was detected. XPS studies revealed the depletion of the surface with copper relative to the bulk composition: 1.5 at. % of Cu was detected on the surface of Ag–2.2at.%Cu solid solution. At the same time the formation of copper-rich nanoparticles was detected by SEM on the surface of Ag–7.95at.%Cu solid solution. Wettability of pure Ag and Ag-Cu solid solution by Cu-Ag melt is analyzed taking into account the diffusion of copper from liquid phase into the substrate and morphology of Cu-rich particles on the Ag surface.

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