Impact of nickel addition on the phase composition and properties of Sn-Ag-Cu solder alloys

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Lead-free solders have been adopted widely due to the environmental and health concerns associated with lead. However, these alloys face several challenges that impact their performance and reliability in electronic applications, e.g. high melting temperature, decrease in mechanical properties, and formation of brittle intermetallic compounds. [1] The addition of nickel has the potential to improve the properties of lead-free solder alloys. [2-4] This study focuses on the addition of Ni into the solder alloy with varying nickel content (0.1-4 mass% Ni) using computational thermodynamics and experimental techniques. For the computational part, the phase equilibria of the system was predicted to analyse the effect of nickel on the solder properties. The experimental part employed various techniques (scanning electron microscopy, energy-dispersive X-ray spectroscopy, X-ray diffraction, and differential scanning calorimetry). From the experimental results, it was found that the primary phases identified were Ag3Sn, β-Sn, and Cu6Sn5. At a nickel content of 1 wt.% or higher, the Ni3Sn4 phase also appeared. As the nickel content increased, the alloy's melting temperature rose sharply, and changes in the solubility of other elements, as well as the stabilization of the Ni3Sn4 and Cu6Sn5 phases, were observed. The analysis revealed that Nickel content significantly influences the phase composition of the alloy.

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