Influence of Nanosized Ni/Ceramic Reinforcements on Mechanical Properties of Sn-3.0Ag-0.5Cu Alloy

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Abstract. The Sn-based lead-free solders are important metal interconnection materials in electronic industry. A miniaturization of soldered joints in electronic devices require the development of new lead-free solders with improved thermophysical and mechanical properties. The Sn-Ag-Cu alloys of eutectic or near-eutectic compositions are considered the most promising and are widely used as solder materials. The reliability of solder joints is especially determined by the intermetallic compound formed at the joint interface. But unlike traditional Pb-Sn solders, Sn-Ag-Cu solders generally have a higher melting point and tin content. Therefore, formation and growth of the intermetallic compound layer occurs faster in the Sn-Ag-Cu solder joints, which leads to brittle fractures and a decrease in the service life of the joints due to thermal fatigue. To improve the properties and strengthen the base solder matrix, various nano-sized admixtures, in particular ceramic, are added. In contrast to metal nanoparticles, they are non-wettable by metal melts. To solve this problem, metallic coatings are applied to their surface to form core-shell structures and to improve adaptation to the solder matrices. As a result, the metal-coated layer forms a strong "bridge" that reacted with the lead-free solders matrix to form an intermetallic layer during soldering. Another important requirement for the lead-free solders application is their reliability in a wide range of operating temperatures, including sub-zero temperatures. In this work, the effect of ceramic nanosized admixtures coated with Ni on the properties and microstructure of the solder joints based on Sn-Ag-Cu was studied both at elevated and sub-zero temperatures.

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