Electronic decive, Vehicle, Aerospace

Lead-free solders reinforced with ceramic particles

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Abstract

This study aims to develop a solder alloy with high strength-ductility, and to obtain high reliability of solder joints. To improve the strength and ductility synergistically, the design concept of multi-scale hybrid reinforcement with ceramic particles has been proposed. In addition, a new surface modification method for ceramic particles, the ball milling-pyrolysis method, has been originally proposed in my research group. The surface modification of ceramic particles, preparation of the composite solder alloy, the interface regulation between the reinforcements and solder matrix, and the mechanical property of composite solder alloys were systematically investigated. This research is expected to provide theoretical and experimental basis for the development of high strength-ductility lead-free solder alloys.

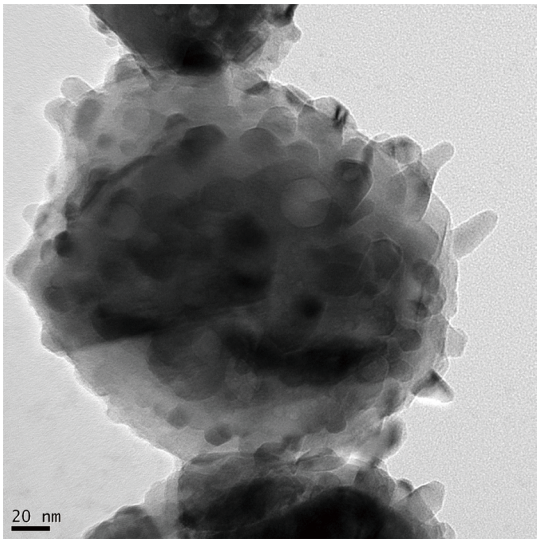
Background & Results

The expanding of electronic products into various new fields, such as the mobility and healthcare fields, requires better properties and reliability for the solder joints on electronic circuit boards. In order to improve the mechanical properties and reliability of lead-free solder alloys, a new concept and method of adding ceramic particles to achieve both strength and ductility has been proposed, and a prototype of lead-free solder alloys reinforced with ceramic particles was produced, and the mechanical property of composite solder alloys were evaluated. The results obtained are described in detail below.

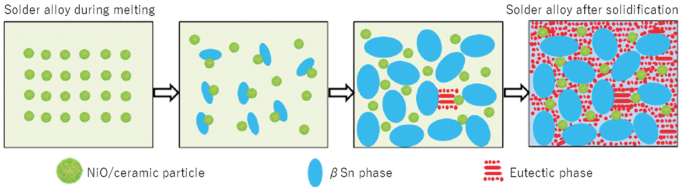
1. A new surface modification method, ball milling-pyrolysis method, was proposed. The proposed method was successfully applied to the surface modification of ceramic particles. In addition, the modification mechanism between NiO and ceramic particle was explored using in-situ transmission electron microscopy (TEM).
2. Reinforced Sn1.0Ag0.5Cu solder alloy was prepared with ultrasonic stirring and the microstructure evolution and refinement mechanism of reinforced solder alloys were systematically confirmed. The modified ceramic particles could act as the nuclear sites. In addition, the melting behavior of the alloys were also confirmed.
3. The ultimate tensile strength and elongation of reinforced solder alloy could be improved synergistically. The ultimate tensile strength was 35.9 MPa and the elongation was 31.4%, which were higher than those of conventional Sn-3.0Ag-0.5Cu solder alloy.

Significance of the research and Future perspective

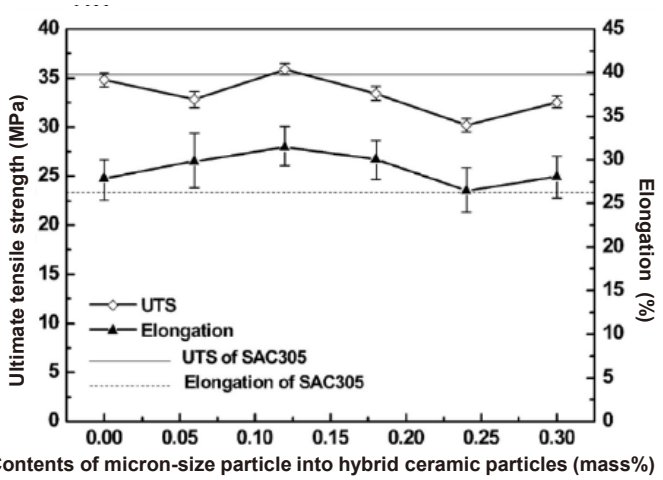
As one way of establishing solder alloys with excellent properties and solder joints with high reliability, a new method of adding non-reactive ceramic particles into solder alloys has been proposed. In particular, the research on surface modification methods was undertaken to improve dispersibility of ceramic particles into solder alloys. The findings obtained in this research can be applied to improve the mechanical properties and reliability of various lead-free solder alloys, including not only Sn-Ag-Cu solder alloys but also low-melting-point Sn-Bi solder alloys and etc.



Ceramic particles covered by nickel oxide



Solidification microstructure of solder alloy with ceramic particles covered by nickel oxide



Mechanical properties of composite solder alloys reinforced with hybrid ceramic particles

Patent
Treatise
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Keyword lead-free solder alloy, surface modification of ceramic particles, mechanical property improvement