AinShamsUniversity
Faculty of Science
Physics Department

Effect of adding nano particles on the physical properties of a ternary Sn-Zn-based alloy

A Thesis

Submitted for the degree of Master Of Science As a Partial Fulfillment of the Requirements of the Master Of Science

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Abstract

Because of the understanding of the harmful effect of lead and lead containing alloys on the environment and human health, many Pb-free solder-alloys have been developed to replace Sn-Pb solders in electronic applications. The European community, US Environmental Protection Agency (EPA), and electronics industries have started initiatives to diminish lead usage. Many lead-free solders have been studied as replacements for Sn–Pb solders.

The Sn-6.5Zn-3In is designed for this study because:

1. It is non-toxic solder alloy and has low cost.
2. It has high wetting property and high corrosion resistance compared to Sn-9Zn based alloys.
3. It has a melting temperature lower than that for Sn-6.5Zn based alloys.
4. It has a pasty range lower than that of Sn-Pb solder alloy, which has a lot of benefits in the industrial applications.
5. It has good mechanical properties.

In spite of all these advantages, its mechanical properties still need more improvement. Therefore, the present work mainly covers studying the effect of adding ZnO nano-particles on the structural, thermal and tensile properties of Sn- 6.5 wt% Zn - 3 wt% In (SZI653) solder alloy.

Thermal analysis and microstructure evolutions of both the plain solder SZI653 and SZI653–0.3 wt% nano-sized ZnO composite solder were discussed. Thermal properties of these solder alloys have been studied by

using the differential scanning calorimetry (DSC) and the microstructure was examined by scanning electron microscopy (SEM) and energy dispersive X-ray spectrometer (EDS). Phase identification of the alloy samples was carried out by X- ray diffractometry (XRD).

Tensile creep tests of the SZI653 plain and SZI653 composite solder were carried out at the temperatures ranging from 20 to 110 ^{o}C under the effect of different applied stresses ranged form 9.1 to 18.1 MPa.

Stress-strain tests for SZI653 plain and SZI653 composite solder alloys were performed under the effect of different strain rates $\varepsilon^{\bullet}$ ranged from 1.33 x 10^{-3} to 1.611x 10^{-2} s^{-1} at different testing temperatures T in the range of 35 to 110 ^{o}C.

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