UNIVERSITI TEKNOLOGI MARA

STUDIES ON INTERMETALLICS AND PHYSICAL PROPERTIES OF Sn-3.5Ag-1.0Cu LEAD FREE SOLDER WITH Zn ADDITIVE

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ABSTRACT

The need for replacing lead based solder has received great attention among researchers because of their toxicity. The Sn-Ag-Cu family is the most promising candidate. However, these solder systems need better improvement in terms of controlling their intermetallic formation, growth rate and also their mechanical properties. In this study, the Sn-3.5Ag-1.0Cu solder was studied and three different amounts of Zn were added into the solder system. The solder was prepared using powder metallurgy method. It was characterized for their melting temperature, hardness and density. For intermetallic study, the solder was melted at 250°C on a Cu substrate and placed in an oven at 150°C until 1000 h. After the aging process, the solder joint was cross-sectioned and analysed under a Scanning Electron Microscope and Energy Dispersive X-ray. The thickness of Cu_6Sn_5 and Cu_3Sn intermetallics were measured using image J software and their growths kinetic were calculated. The shear joint specimen was aged until 1000 h and the joint strength test was performed using an Instron machine. The addition of Zn has no significant effect on their melting temperature. Density and hardness results show that the optimum condition in preparation of solder disc was 2 h is mixing time and 14 MPa pressure. The addition of Zn retarded the growth of the intermetallic with 0.4 wt.% Zn gives the most significant values compared to 0.1 and 0.7 wt.% Zn addition. The growth of intermetallic compounds followed a parabolic law, implying that the growth of the intermetallic layer was diffusion control. The addition of 0.4 wt.% Zn gives the smallest growth constant (k) which are 0.16×10^{-14}, 2.56×10^{-14} and 4.00×10^{-14} cm^2/s for Cu_6Sn_5, Cu_3Sn and total intermetallic, respectively. Smaller k value indicates that the growth of intermetallic was slower and thus Zn retards the intermetallic growth. The decreasing of solder joint strength as aging time increases can be correlated to the growth of the intermetallic. Solder composition with the addition of 0.7 wt.% Zn has the highest stress values which is 20.14 MPa for as-soldered and 15.30 MPa for 1000 h aging time.

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