

The effects of Bi addition on the mechanical properties of eutectic Sn-Ag-Cu lead-free solder alloy

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Sn-Ag-Cu (SAC) solders are gaining momentum as the choice of Pb free electrical interconnect materials because of the legislative restrictions on the use of hazardous materials in electronic devices. However, SAC has high melting temperatures around 217°C. The role of Bi substitution to lowering solder joint processing temperatures are widely considered because of the low-temperature Sn-Bi eutectic. However, the embrittling effects of Bi addition require clarification on the maximum limits of substitution. In this work, the mechanical properties of eutectic SAC with gradual Bi substitution up to 10wt.% Bi was followed. It is shown that fracture strength (σ_f) increases from 50MPa plateauing at 60MPa between 1.4 and 1.8%Bi representing the limits of solid solution strengthening. Over this substitution range, strain at fracture (ϵ_f) dropped from 30% to 10% and reduction in area (RA) dropped from 80% to less than 5%. The σ_f was nearly 80MPa for 2%Bi and this increases gradually with %Bi concentration peaking at 93MPa for 7%Bi. Results of thermal analysis suggested that solidification went off eutectic after Bi concentration exceeded 2%. Using neutron diffraction techniques, the lattice parameter measurements suggest that the solubility limit of Bi in Sn (in the multicomponent Sn-Ag-Cu) is about 2wt. %. The existence of Bi rich clusters was responsible for observed brittleness after 2wt.% Bi substitution. With the aid small angle neutron Scattering (SANS) and ultra-small angle neutron scattering (USANS), it was found that the intensity changes with respect to scattering factor (Q) especially for high Q region when the precipitations sizes are below 12.5 nm after concentration exceeded 2%Bi that confirms the existence of primary nanosized Bi precipitates that starts to grow into well-defined Bi phases for higher Bi content.

Level of Expertise

Experienced Research

Speakers Gender

Male

Do you wish to take part in the poster slam

No

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