Interfacial Reactions between Ni Substrate and Microelectronics BiSn Solder

ABSTRACT

Two sets of experiments were carried out in this work. The first is the reaction between solid Ni and liquid 58Bi42Sn (wt.%), and the second is the reaction between solid Ni and solid 58Bi42Sn. The alloy 58Bi42Sn is a strong Pb-free candidate for replacing the 37Pb63Sn solder, while Ni is used in many printed circuit board (PCB) and ball grid array (BGA) package surface finishes. In solid/liquid reaction, experiments were carried out at 180, 240, 300, 360 and 420 oC for 0.5 to 48 hours. It was found that a reaction zone formed between Ni and BiSn alloy. Reaction at 180 oC produced a thin reaction layer of Ni3Sn4. The average thickness of the reaction layer increased slowly with reaction time, reaching 14mm after 48 hours. Reactions at 240 to 360oC produced thicker reaction layers with increasing reaction temperatures and time, and some Ni3Sn4 pieces were dispersed in the BiSn alloy. Reaction at 420oC produced a two-phased reaction zone composed of Ni3Sn4 and BiSn alloy, and the amount of Ni3Sn4 dispersed in BiSn alloy was largest. The growth mechanism changed at 360oC. The growth of Ni3Sn4 was diffusion controlled with an activation energy of 23 kJ/mol below 360oC, and it became reaction controlled with an activation energy of 78 kJ/mol at temperature above 360oC. In solid/solid reaction, experiments were carried out at 85, 100, 120, and 135oC for 25 3600 hours. It was found that Ni3Sn4 with layered structure formed between Ni and BiSn alloy. Analysis using electron microprobe showed that Ni3Sn4 has the composition of 56.9±0.6 at.% Sn. The growth of Ni3Sn4 layer was diffusion controlled with an activation energy of 177 kJ/mol.