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The influence of Ni and Zn additions on microstructure and phase transformations in SnCu solder joints

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Microalloying, in which the solidification structure is preferably and significantly modified by trace elements, is a key method for improving Pb-free interconnections in electronic devices. Microalloying Ni or Zn is expected to modify the Sn-0.7Cu alloy in different ways. This research examines the influences of minor/trace additions of Ni and Zn concurrently on the development of the microstructure, the interfacial reactions and the stability of the intermetallics in Sn-0.7Cu solder alloys and associated joints, using X-ray radiography, X-ray fluorescence analysis, X-ray diffraction and electron microscopy. It shows that minor Zn additions (0.15 wt.%) result in the formation of a CuZn intermetallic in the interdendritic region during solidification, whereas a small amount of Ni completely changes the solidification mode and a eutectic microstructure is obtained. When Ni is added, small particles of primary (Cu,Ni)₆Sn₅ intermetallic forms in advance of the solidification front. Microalloying Ni and Zn concurrently refines the microstructure and leads to a more continuous, finer-grained and stable interfacial Cu₆Sn₅ intermetallic and suppresses the growth of Cu₃Sn. The Ni and Zn are homogeneously distributed in interfacial Cu₆Sn₅ and inhibit the polymorphic phase transformation of Cu₆Sn₅. This stabilizing effect minimizes the thermal expansion mismatch between interfacial Cu₆Sn₅ and the Cu substrate. The findings have important implications for the manufacture of high-reliability lead-free microjoints.

Keywords

Intermetallic compounds; X-ray synchrotron radiation; Phase transformations

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