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Abstract

A typical electronic device consists of mainly three parts namely integrated circuits, printed circuit board (PCB), and interconnections joining these two parts. The solder joints are commonly used for these interconnections which serve two purposes i.e., both as an electrical connection and a mechanical joint. The ball grid array (BGA) arrangement of interconnections is commonly used owing to its simple design. The increasing use of electronic devices in harsh environments such as the military, aerospace, and aviation make the solder joints subjected to various thermo-mechanical loads. As the size of these joints is relatively smaller (cross-section), it leads to higher stresses and thereby making them more prone to failure. So, the failure characterization of the solder joints needs to be done to improve the reliability of the joint.

In this work, the effects of factors such as bond-line thickness, mode-mixity of fracture, aging time, loading rate, and Ag content in the solder were studied on the fracture behavior of the solder joints using DCB specimens. A mix of experimental and finite element modeling based approaches was used to characterize the joint failure. The mode-I and mixed-mode fracture tests were done to study the effect of these factors. The fracture toughness of the joint, and the ductility during fracture increased with increasing bond-line thickness in the studied range of 440 – 880 μm. Increasing the mode-mixity of fracture in the range ψ = 0 – 33°, marginally increased the fracture toughness of the joint. The FE model using the TSL predicted the failure of the joint reasonably well. The fracture toughness of the joint decreased significantly and the failure changed from ductile to brittle with increasing aging time. Increasing the loading rate first increased the and then significantly decreased fracture toughness of the joint. The failure behavior also changed from ductile to a mix of ductile and brittle failure with the increasing loading rate. The Sn-0.7Cu/Cu solder joint had significantly higher fracture toughness than SAC0307/Cu and SAC305/Cu solder joints. Overall, it was observed that these factors have a significant effect on the reliability and failure behavior of the solder joint.