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Reliability of Lead-Free Solder Joints Under Combined Shear and Compressive Loads

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ABSTRACT

In electronic assemblies, solder joints are used to create electrical connections, remove heat, and mechanically support the components. When an electronic device is powered on, the solder joints and the board they are attached to heat up, expanding at different rates. Due to the difference in expansion, shear stress is imposed on the solder joints. As the device is powered on and off, this shear stress can eventually fracture the solder joint, causing the device to fail. Therefore, to increase the lifespan of electronics, it is important to investigate the mechanical properties of solder alloys. The present study investigates how the SAC 305 solder alloy (96.5% Tin, 3% Silver, 0.5% Copper) degrades under simultaneous compressive loading and shear cycling. The effect of compressive load on solder joint life has not been systematically studied in prior work but is critical to understand as large heat sinks are bolted onto increasingly large electronic assemblies, adding compressive stress on solder joints. To gather data, we constructed a custom shear tester. Shear loads were applied using a programmable motor. A pulley system applied compressive loads.Tests were conducted on a large number of samples under varying shear and compressive loads. The data showed that, for compressive loads below 30N, increasing the compressive load decreased the rate of damage to the sample. However, at the highest compressive load of 45N, the sample fractured immediately. This suggests that applying small compressive loads to critical components of electronic devices could improve their long-term reliability.

KEYWORDS

Solder Alloys, Lead-Free Solder, Creep, Cyclic Fatigue, Fracture