Reliability Analysis and Finite Element Modeling of a Flexible Hybrid Electronic Device

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Abstract

Flexible Hybrid Electronic (FHE) devices which interface flexible substrates and sensors with conventional rigid electronic components are garnering increased attention due to their advantages of being conformal, light weight and cost efficient. These devices present a new set of reliability challenges due to their high flexibility.

We are reporting work done to improved reliability of flexible circuit of a FHE device designed to measure ECG and skin temperature. The device is fabricated on a 2" X 2" flexible Kapton® polyimide substrate of 50 µm thickness. Sensors to measure ECG and skin temperature were printed on one side of the substrate whereas conventional rigid electronic components were mounted on the other side for signal conditioning and communication purposes. The sensors were connected to the electronic components using a flexible 2 µm thick Cu circuit and Sn63Pb solder.

The device had reliability issues due to cracking of the Cu circuit near the signal conditioning chip. Multiple test vehicles were fabricated using either 2 or 6 µm thick Cu circuit, 50 or 125 µm thick polyimide substrate and either Sn63Pb or Sn42Bi solder. The aim was to determine the most reliable combination under bending loads which the device will be subjected to in real life use. The test vehicles were bend tested and optical microscopy was used to document defects formed in the circuit and device most resistant to defect formation was determined. Cross-sectioning of defect locations was done to better understand nature of defects.

Finite element modeling was done to correlate experimental and simulation results. It was seen that both the results showed excellent correlation.