Correlation of Physics-of-Failure to Stress-strain Curve for Quick-turn Monitoring of Solder Joint Reliability

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ABSTRACT

Physics-of-failure based reliability prediction technology is one of the key technologies in the field of prognostic and health management (PHM). In this study, physics of failure in solder interconnection is correlated with stress-strain curve obtained by die pull test to predict the joint quality and monitor the property change of solder bump within a reduced time period. Ball-grid-array (BGA) Si chip containing 6,000 solder bumps is used to demonstrate the validity of proposed method. With the conventional method using SEM analysis, it is very time-consuming to observe every single micro-bump and define each failure mode especially when IC includes a great number of solder bumps. The results indicate that it is possible to establish quick-turn monitoring methodology for the solder interconnection reliability and property change from the stress-strain curve of solder joints. Baseline strain-rate for ductile to brittle transition for reference joint of Sn-0.7Cu solder composition is investigated so that all the other deviations from the reference can be captured by using stress-strain relationship. In addition, it is found that failure mode in solder joint is correlated with stress-strain plot and therefore, joint reliability can be predicted without identifying the failure mode of the joints through SEM inspection. This study can provide the guideline for solder joint PHM from solder bump to chip system level.

KEYWORDS: Physics of failure, solder joint, reliability, stress-strain curve, ductile to brittle transition (DTBT)