Microelectronics International, vol. 28(1), 2011, pages 17-28

# Temperature cycling analysis for ball grid array package using finite element analysis


## Abstract

Purpose - The purpose of this paper is to discuss the capability of finite element analysis (FEA) in performing the virtual thermal cycling reliability test to evaluate the reliability of solder joints in a ball grid array (BGA) package. Design/methodology/approach - Thermal cycling test has been used to evaluate the reliability or fatigue life of the solder joints in BGA package using commercially available FEA software, ANSYSe. The effect of different temperature cycling condition is studied by applying different value of dwell time and ramp rate. Two types of analyses are used namely, the physics-based analysis and the statistical-based analysis. Two screening design methods namely, central composite design (CCD) and Box-Behnken Matrix Design method are used to isolate the most important factors amongst six selected design variables. The optimization process is carried out using response surface methodology (RSM). Findings - It is observed that changes in ramp rate produce significant effect in solder fatigue life than changes in dwell time but the dwell time at high temperature has a negligible contribution to solder fatigue life. It has been found that the thickness of the mold has a significant effect on the performance of the solder joint reliability (more than 50 percent) as compared to that from other factors. Besides, the effect of individual factor, the interaction among factors also changes the solder joint reliability. RSM based on Box-Behnken Matrix design offers the highest characteristic solder joint fatigue life with a value of 2,861 cycles. Originality/value - This paper provides a comprehensive method to evaluate the reliability of solder joints in terms of physics and statistical-based analysis.


**Keywords —** Finite element analysis, joining processes, soldering, stress (materials), surface fitting