Impact of the number of chips on the reliability of the solder balls for wire-bonded stacked-chip ball grid array packages

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Abstract

This investigation examines how the number of chips affects the reliability of solder balls for wire-bonded stacked-chip ball grid array packages under thermal cycling tests. The studied objects were packages with one, two, three and four stacked chips. Three-dimensional finite element analysis was utilized to simulate the stress/strain behavior of all studied packages. Two kinds of properties of 63Sn/37Pb eutectic solder were employed individually in the finite element analyses. One property of the solder was assumed to exhibit the elastic-plastic-creep behavior. Temperature-dependent stress/strain curves and Norton's steady creep equation were used in the analysis. Another property of the solder governed by the Anand's viscoplastic model was also employed to describe the behavior of solder balls. The simulation results in the elastic-plastic-creep analyses and viscoplastic analyses reveal that the von Mises stress, the non-linear strain, and the inelastic strain energy density of the critical solder balls increase with the number of stacked chips, but the increments become gradually stable as the number of chips increases. Three fatigue life prediction models—Dar-

veaux ‘s model,
the modified Coffin-Manson model and the creep-fatigue model—were applied to
evaluate the fatigue life of the studied packages. Prediction results indicate that the
fatigue life of the solder balls decreases as the number of stacked chips increases, and the
decrease in predicted life shows stable behavior as the number of chips increases. The
stable trend is consistent with experimental observation in the thermal cycling tests. By
comparing with the experimental data, it is shown that the Darveaux’s model gives better
prediction than the other two models.

Keyword：