Proceedings of the 9th World Congress on Mechanical, Chemical, and Material Engineering (MCM'23)
Brunel University, London, United Kingdom - August 06-08, 2023
Paper No. ICMIE 134
DOI: 10.11159/icmie23.134

Temperature Dependent Deformation Analysis of WB-PBGA Package Assemblies Using Moiré Interferometry

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Extended Abstract

Plastic ball grid array (PBGA) package assemblies consist of various materials with different thermo-mechanical properties. The non-uniform properties of the silicon die, molding compound, printed circuit board (PCB), and solder interconnections result in variations in strain within the PBGA package assembly. Cyclic thermal loading can further induce fatigue cracking of solder interconnections in the package assembly. Reliability testing, such as ATC tests, can be more effective in predicting solder interconnections with a high probability of failure among many interconnections.

Moiré interferometry is a full-field optical method that provides high-sensitivity displacement measurement and high spatial resolution [1]. Recently, its applicability has been extended to the thermal deformation analysis of microelectronic devices [2,3]. This paper characterizes the thermo-mechanical behavior of an overmold-type wire bonding PBGA package assembly using moiré interferometry, focusing specifically on the effect of solder ball grid patterns.

Experiments were conducted on three types of WB-PBGA packages: full grid pattern (WB-PBGA-FG) and perimeter pattern with/without central connections (WB-PBGA-PC/P). Fringe patterns representing the displacement distribution at several temperature levels were obtained, and the bending deformation behaviour and strain of solder balls were compared. Our findings reveal significant differences in both bending deformation behaviour and the position of the critical solder ball due to thermal strain, depending on the type of solder ball grid pattern. In the case of WB-PBGA-PC/P, the bending displacement at the end was the largest, while in the case of WB-PBGA-P, the displacement at the end was small due to the S-shaped deformation of the package. The critical solder ball was located at the edge of the chip for WB-PBGA-FG, the outermost solder ball of the central connection for WB-PBGA-PC, and the internal solder ball closest to the chip for WB-PBGA-P. Among the three types of WB-PBGA packages with different solder ball arrangements, WB-PBGA-PC/P exhibited the largest bending strain under the same temperature conditions, leading to the most significant effective strain affecting solder ball breakage.

Acknowledgements

This paper was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) (NRF-2020R1I1A3073955

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