Product Level Design Optimization for 2.5D Package Shock Impact Reliability

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2.5D packages have been widely used in the electronics industry for its high integration density and heterogeneous integration ability. It has become one of the best technical solutions for high-end products, such as GPU, computing, and FPGA. The package qualification process requires that it passes the board level drop test before shipping, however, this doesn't always guarantee that the package will survive from product level drop, especially for a complicated design product. It is critical to optimize the product design with consideration of package interconnections shock reliability.

In this study, the 2.5D package of a PCIe card's BGA failure risk in a drop event was analyzed both numerically and experimentally, and the product design was optimized. In the PCIe card, a 2.5D FPGA package was connected onto a PC board by the BGA. The heat sink was held onto the package with spring screws. The whole assembly was then sandwiched between two metal plates to improve the product integrity. Those parts can add large inertia to the package during the drop, which will pose more reliability risk on the BGA interconnections.

During the drop test, the PCIe card was inserted into a server box and fall together onto a drop table. The dye and pry result shows that the package experienced corner solder pad cratering failure. Finite element model of the PCIe card was built and validated by die surface stress measurement. The assembly initial warpage was taken into consideration during the die stress analysis. The direct acceleration method was used to simulate the product drop event. With the validated model, a parametric study was conducted regarding the top plate material, package edge bonding, SMD (solder mask design) and NSMD (none solder mask design)'s effect on the corner BGA stress level during the drop. The results show that the stainless-steel top plate can reduce the corner BGA stress compared with the aluminum top plate. The edge bonding can help to hold the package and PCB together during drop so that to reduce the corner BGA stress level. Compared with the NSMD case, the SMD can reduce the stress level of the corner BGA. The optimized design of the product shows a better drop reliability. This study provides a systematic way to analyze the 2.5D package product's BGA failure risk during a drop event and give guidance to optimize the product design.