MECHANICAL BALL SHEAR, ELECTROMIGRATION AND THERMAL CYCLING RELIABILITY TESTING ON NOVEL SOLDER INTERCONNECTS OF HIGHLY INTEGRATED CHIPS FOR ADVANCED APPLICATIONS

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In the near future, Ultra Large Scale Integrated Circuits (ULSI) with high integration has drawn the huge attention because of its potential applications in VR, AI, IoTs and automotive regions. Thermal budget and reliability concerns are two major issues that are urgently needed to be solved for these technologies. Since the increasing integration of ICs might lead to low yield concern, low fabrication temperature is expected to reduce the thermal impact on ICs properties. Besides, better reliability is also required to the electric devices for those to work under harsh outdoor environments. This study is tended to be focused on the novel solder bonds for the advanced ICs, including low temperature solder, Cu-core solder ball, and their response under various reliability tests. Three main reliability tests: (1) ball shear test, (2) electromigration test (EM) and (3) thermal cycling test (TCT), are conducted to evaluate the reliability of solder bonds. In this work, the novel Bi-40In solder alloy with improved mechanical property and the EM-resisted Cu-core solder ball are demonstrated. The re-designed low temperature solder joint reveals the superior ball shear strength than that of conventional eutectic Bi-33In joint. Additionally, the interconnects using Cu-core solder ball show the high resistance against EM under current stressing. Regarding TCT, the assemble joints with various grain structures are tested to realize the effects of Sn grain size on joint degradation and the possible ways for relieving the thermomechanical stress caused by TCT. The microstructure, elemental characteristics and grain structure are analyzed by FE-SEM, FE-EPMA and EBSD, respectively. The failure mechanisms for all reliability tests are addressed and discussed in details as well.