This is an abstract of the technical paper/presentation that was originally presented at
International Conference on Soldering and Reliability
May 14-16, 2008
Hilton Airport Hotel
Toronto, ON, Canada

Relationships Between the Impact Strength and Microstructure of Lead-Free Solders

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ABSTRACT

Concern about the failure of lead-free BGA packages when portable devices such as cell phones are accidentally dropped and a general concern about the resistance of these packages under shock loading has prompted an interest in the impact strength of the soldered BGA connection. Results have already been reported on the measurement of the impact strength of lead-free 1.6mm diameter BGA spheres on 0.42mm solder mask defined pads on copper/OSP and ENIG substrates using recently developed equipment that can load individual BGA spheres at high strain rates in shear and tension. Two lead-free solders, Sn-3.0Ag-0.5Cu (SAC305) and a silver-free Sn-0.7Cu-0.05Ni-0.006Ge (SCNG) were studied with Sn-37Pb included as a benchmark. To study the effect of intermetallic growth on impact strength BGA were tested after up to two reflow cycles and 200 hours ageing at 150°C. BGA were tested in shear at speeds of 10, 100, 1000, 2000 and 4000mm/sec and in tension at speeds of 1, 10, 100, 200, and 400mm/sec. While at load rates lower than about 100mm/sec in shear and 10mm/sec in tension the energy required to detach the SAC305 was higher than that required to detach the Sn-Pb of SCNG sphere, at higher speeds the SAC305 failed in a brittle manner at low impact energy while the SCNG alloy required more energy even than the Sn-Pb and exhibited a high proportion of ductile fracture. The analysis of the results of this test program has continued and in this paper the authors will report on the investigation of the relationship between the energy absorbed during impact fracture and the microstructure of the solder, in particular the intermetallic at the solder/substrate interface. These results indicate that because of the stability of their microstructure some lead-free solders are more suitable than others for applications where they might be subjected to shock loading.