

**A study in the reactions between SnAgCu lead-free solders
and Au/Ni surface finish in BGA packages.**

ABSTRACT

Lead-bearing solders, such as the PbSn eutectic, have been used extensively in the microelectronic industry for a long period of time. Recently, the European Union proposed to phase out the lead-bearing solders by January, 2008. Moreover, many major Japanese electronic companies, such as Panasonic and Fujitsu, have decided to switch voluntarily to lead-free processes by the year of 2002. It is generally believed that this lead-free transition is inevitable this time. Past research by the academia and industry indicated that a drop-in replacement for PbSn eutectic is difficult to find, if not impossible. Due to the extremely tight time schedule to go lead-free, the U.S. industry had reached a consensus to use SnAgCu series of solders to replace the PbSn eutectic, despite the fact that the literature for SnAgCu solders is still seriously lacking. The main objective of this proposal is then to study the reactions between such lead-free solders with the Au/Ni surface finish used in the industry.

The SnAgCu solders are a series of solders with broad compositions. We propose to study the effect of the Cu concentration on the interfacial reaction. The Au/Ni surface finish is the most common and important one for solder pads and bumps in the industry now. Therefore, the overall objective is to study in depth the reactions between the SnAgCu solders

with various Cu concentration and the Au/Ni.

The contact pads for solder balls on the PBGA substrates used in this study have the 0.8 μ m-Au / 8 μ m-Ni surface finish by electroplating. The solder composition, Sn-3.5Ag, Sn-3.5Ag-0.75Cu, Sn-xAg-0.5Cu (x=1/3/4 wt.%), and Sn-3Ag-yCu (y=0/0.3/0.5/0.7/1 wt.%), were used, and their performances were compared. After reflow, the solder joints were subjected to aging at 180 °C for time up to 2500 hrs. The shear strengths of the solder joints with different aging time were then tested.

It was found that the Cu concentration in the SnAgCu ternary solder has a very strong effect on the compound formation and the shear strength in solder joints with the Au/Ni surface finish. When there was no Cu (ex:Sn-3Ag), the reaction product was Ni₃Sn₄. When the Cu concentration was high (ex:Sn-3Ag-1Cu), the reaction product was (Cu_{1-p-q}Au_pNi_q)₆Sn₅ right after reflow, and two intermetallic compounds (Cu_{1-p-q}Au_pNi_q)₆Sn₅ and (Ni_{1-y}Cu_y)₃Sn₄ formed after aging at 180 °C for 2500 hrs. When the Cu concentration was 0.5 wt.% (ex:Sn-3Ag-0.5Cu), both Ni₃Sn₄ and (Cu_{1-p-q}Au_pNi_q)₆Sn₅ were present near the interface right after reflow, and there was a layer of solder between these two intermetallic compounds. After aging, a layer of (Cu_{1-p-q}Au_pNi_q)₆Sn₅ over a layer of (Ni_{1-y}Cu_y)₃Sn₄ formed at the interface.