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Electroplating of AuSn Solders onto Patterned Substrates for Packaging Applications

With the increasing demand for reducing the size of electronic and optoelectronic parts, numerous attempts have been made in the packaging industry to miniaturize bonding media features in order to meet the new requirements. This has necessitated the use of more delicate processes for depositing and placing solders between submounts and dies. Among the different available processes, electroplating seems most promising, because of its simplicity and low capital cost.

AuSn eutectic solder has excellent mechanical and thermal properties compared with traditional PbSn solders. It is especially ideal for flip-chip techniques and laser bonding in electronic/optoelectronic packaging.

The gold-tin binary phase diagram contains two eutectic transformations; one occurs at 280 °C (Au-20Sn wt%) while the other at 232 °C (Au-90Sn wt%). The latter is not of much interest because it forms brittle phases that are deleterious to packaging applications. The former eutectic composition is widely used for soldering. The Au-20Sn (wt%) eutectic composition consists of two phases, AuSn and Au_5Sn. The Au_5Sn phase forms at compositions ranging from Au-6Sn (wt%) to Au-12Sn (wt%) and is essentially the matrix phase (65 volume percent) for the eutectic. The AuSn phase forms at Au-38Sn (wt%) and is harder than Au_5Sn. The soft Au_5Sn phase bears most of the plastic deformation applied to the solder, whereas the hard AuSn phase gives strength to the structure.

Micralyne Inc. has exclusive right to use a patent for pulse-alternating plating of AuSn alloys on substrates with Au seed layers using a slightly acidic, chloride based solution. Alloys with Sn concentrations of ~10wt% and ~38 wt% can be reproducibly deposited at current different current densities. These concentrations correspond to Au_5Sn (10 wt% Sn) and AuSn (38 wt% Sn) intermetallic phases. By alternatively electroplating the two phases, any Sn concentration between 10 and 38 wt% can be deposited by adjusting the electroplating time for both phases. For example, Au-Sn solder films up to 40µm in thickness have been successfully plated by depositing alternating Au_5Sn and AuSn layers, from a single solution, to obtain the eutectic composition (20 wt%Sn). After reflow at 280°C for a couple of seconds, a typical eutectic microstructure is formed. This example demonstrates that Au-Sn alloys with different melting points, including the eutectic temperature (280°C), can be fabricated for specific applications without changing the electroplating bath.

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