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The Effect of Carbon Content on the Solderability/ Reflowability of Tin & Tin-Lead Electrodeposits

Introduction

Tin and tin/lead coatings have been used extensively in the electronics industry as interconnection materials and as final surface finishes. One of the requirements for the coatings is to have "long-term" solderability and be reflowed without dewetting.

Finish	Carbon Content, %	Thermal Bake Test
Satin bright tin	0.004	pass: no dewetting, no discoloration
Satin bright 90/10 tin/lead	0.01	pass: no dewetting, no discoloration
Bright 90/10 tin/lead, A	0.02	pass: no dewetting, no discoloration
Bright 90/10 tin/lead, B	0.07	fail: dewetting, no discoloration
Bright 90/10 tin/lead, C	0.1	fail: dewetting, slight discoloration
Bright tin	0.2	fail: dewetting, severe discoloration

The following factors, as schematically represented in Fig. 1, affect solderability and reflowability of electroplated Sn and SnPb electrodeposits: organic inclusion, surface oxides and intermetallic compounds.

Organic inclusions are particularly significant since most electroplating processes utilize "organic addition agents" to impart brightness to the deposits. It is known that organic inclusions can have a detrimental affect on solderability and reflowability. The accompanying table attempts to quantify this relationship.

Organic content can be assessed by a number of methods. Elemental gas fusion analysis remains the most direct and accurate, and provides quantitative results. It is tedious, however, and requires sophisticated instrumentation. A quick method is the thermal bake test.* The table establishes the relationship between carbon content and reflowability.

Problem

A connector manufacturer was experiencing difficulties meeting reflowability requirements for a bright 90/10 tin/lead finish. It experienced gross dewetting when the plated parts were reflowed.

Analysis

The bright 90/10 tin/lead was plated over a nickel underlayer, which was plated over a copper substrate. The nickel layer (chemistry and process) might have contributed to the problem. Two approaches were taken.

On the deposit side, failed production samples were examined by optical microscopy and SEM as shown in Figs. 2 and 3.

Dewetting was evident because of the presence of blisters (Fig. 2) and

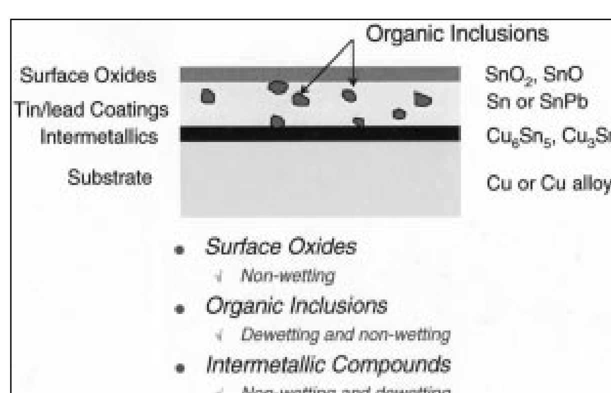

Fig. 1—Factors that affect solderability and reflowability of electroplated Sn and SnPb electrodeposits.

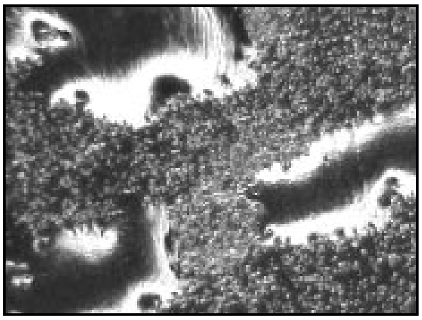

Fig. 2—Optical microscopy of failed production sample.

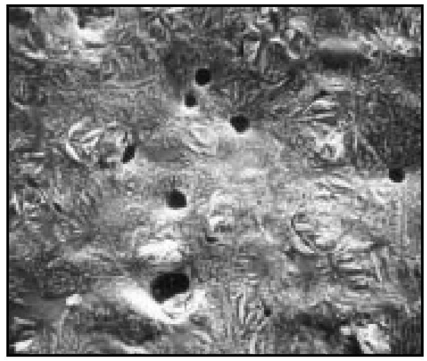

Fig. 3—SEM of failed production sample.

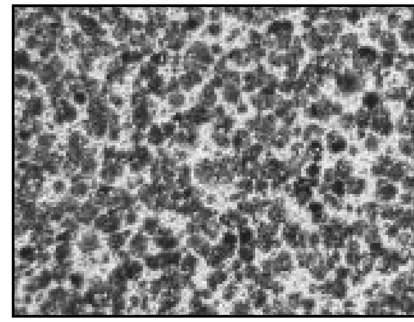

Fig. 4—Surface morphology of the proprietary 90/10 tin/lead layer deposits over nickel after thermal bake.

the large number of pits (Fig. 3) on the surface; EDAX analysis demonstrated that the Cu substrate was exposed through the pits. Elemental analysis of the deposits showed carbon content as high as 0.2 percent.

Newly prepared tin/lead and nickel baths were made using the customer's chemistries. Deposits were prepared under production conditions maintaining the thickness and composition as per specifications. The deposits were then subjected to the thermal bake test. A degree of dewetting similar to the production samples was observed with and without the nickel layer.

Based on these experiments and the results shown in the table, it is apparent that the dewetting problem was caused by the organic content of the solder layer.

To unambiguously support the above conclusion and recommend a solution to the customer, a bright 90/10 tin/lead chemistry was utilized in an identical set of experiments. This process** produces deposits with carbon content less than 0.03 percent.

Figure 4 displays the surface morphology of the proprietary 90/10 tin/lead layer deposits plated over nickel after thermal bake. As can be seen, no dewetting is observed.

Solution

The dewetting problem was caused by the high organic content in the deposit of the customer's bright tin/lead chemistry. Our recommendation to use the low-carbon inclusion chemistry solved the dewetting problem. P&SF

Developed by Electroplating Chemicals & Services (EC&S), Staten Island, NY.
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