Pinpointing Tin/Lead Thickness

How do today's X-ray fluorescence systems measure up? New numbers provide new insight.

Frank Reilly

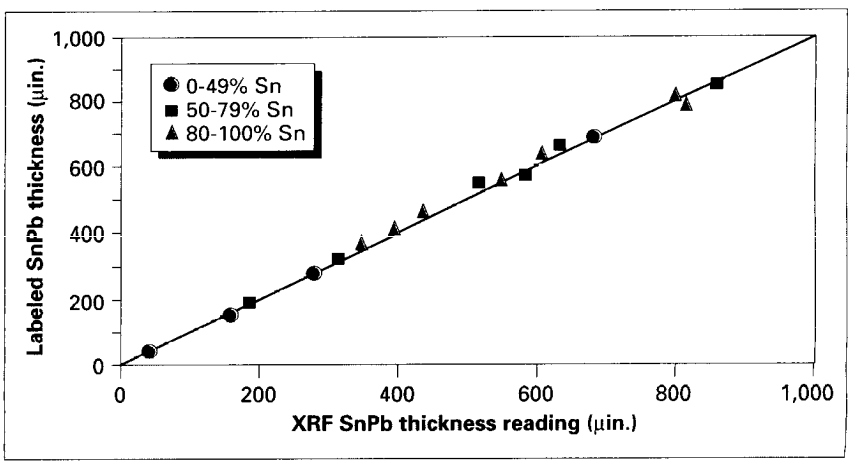
The trend toward finer lines and spaces, being driven by packaging technology, has had a dramatic impact on virtually every phase of printed circuit manufacture. The tin-lead plating process is no exception.

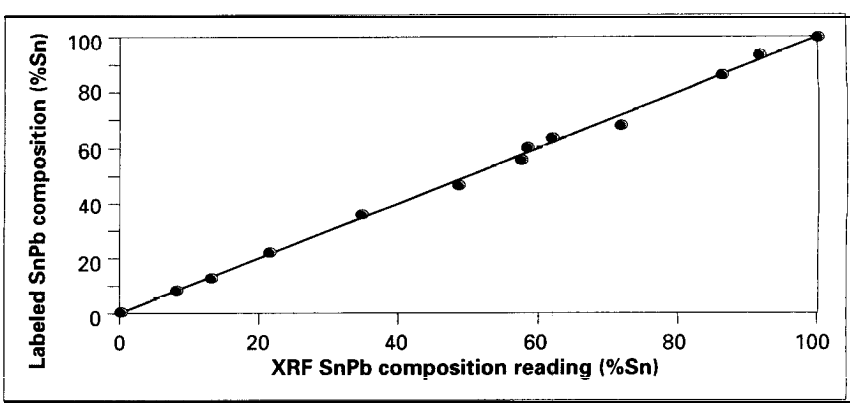
An increasingly critical factor in tin-lead plating is the ability to ensure uniform thickness and composition. This requires an accurate, reliable method for measuring such deposits.

A recent experiment involving the use of X-ray fluorescence (XRF) systems for pinpointing tin-lead coating thickness and composition yielded some interesting results. This article will describe the methodology and the findings of the experiment.

setup

Measurements were accumulated on an X-ray fluorescence analyzer equipped with a microfocus molybdenum target beryllium window X-ray tube and an autofocusing laser. The system is based on an algorithm that simultaneously measures the composition and thickness of tin-lead alloy plating on a variety of base materials. Tin-lead calibration software was coupled with tin-lead calibration foil standards to measure the full range of alloy composition (i.e., from pure lead through pure tin). Samples of up to 400-µ (10-microns) thick for pure





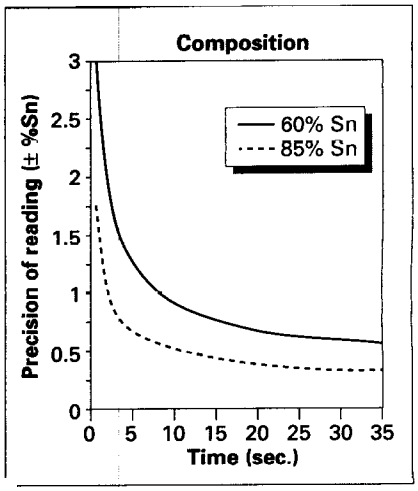
Figures 1 and 2. Labelled SnPb thickness vs. XRF readings.

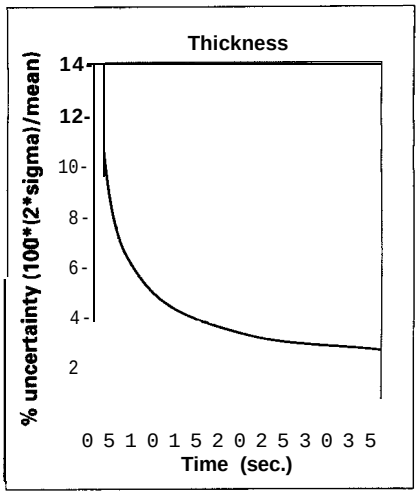
lead to 3,000-µ (75-microns) thick for pure tin were measured.

Standards

The use of tin-lead foil standards allows calibration to be performed using base materials identical to the sample under analysis. A base correction mode compensates for variations in the material.

The tin-lead foil standard set used for calibration contains both pure lead and pure tin thickness standards. Four tin-lead thickness standards ranging from 60 to 90% Sn were also used in the calibration. Through these measures, a method of verifying calibration accuracy was provided.





Figures 3 and 4. Precision of tin-lead on copper thickness and composition XRF readings taken with a 12-mil beam on 390-µin., 60- to 85%-Sn samples.

Method

Early X-ray fluorescence instrumentation used the attenuaion of the substrate X-ray by the tinlead plating to measure tin-lead thickness. This technique cannot accurately measure plating thicknesses exceeding 300 to 500 µ (7.5 to 12.5 microns). Also, the exact upper measuring limit depends on the base material, and measurement accuracy may be adversely affected by coating composition and any

intermediate layers that may be present.

Recently developed XRF instruments incorporate an X-ray emission algorithm that uses the tin and lead X-rays from the alloy plating to measure coating thickness, independent of the substrate X-rays. Basically, the calibration works as follows: The XRF system determines the functional relationship between tin-lead plating thickness and the intensity of both the tin and the lead X-rays, These functions are calculated at O, 60,90, and 100% Sn. The software then calculates how the ratio of the tin-to-lead X-ray intensity varies as a function of thickness and composition. By alternately evaluating these relationships, the software determines the thickness and composition of the tin-lead plating on a sample.

Results

Figure 1 shows data gathered through measurements of tin-lead standards ranging in composition from O to 100% Sn and ranging in thickness from 40 to 800 µ (1 to 20 microns). Figure 2 shows data gathered through measurement of the composition of standards ranging from O to 100% Sn. As can be seen, tin-lead plating thickness can be measured with an accuracy better than ± 7% or ± 5µ (0.13 micron), whichever is greater. Composition can be measured with an accuracy better than ± 2% Sn. Figures 3 and 4 show the degree of precision of the tin-lead measurement using a two-sigma confidence interval. When a 12-mil (0.3-mm) beam size is used, a 400-µ, 60- to 90%-Sn sample can be measured with a thickness precision of ± 4% within a 10-second interval. Under the same conditions, the precision of the composition reading is ± 0.5% Sn for a sample composed of 85% Sn and ± 1% Sn for a sample composed of 60% Sn. FAB

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