TECHtips

Electronics Manufacturing Insights from ACI Technologies, Inc.

Microscopy in Failure Analysis

Both optical and scanning electron microscopy (SEM) are powerful tools for failure analysis in electronics and are used for low and high magnification examination. This article will provide detailed, step by step information for examining solder joints.

Before using the high magnification of the SEM, a traditional optical microscope or an inverted optical microscope is used to locate your area of interest. For most external inspections, optical microscopes are useful to locate any obvious defects or anomalies on boards and components. For internal inspections, the sample can be cross-sectioned (or "microsectioned") to reveal layer by layer structure of a component on a printed wiring board. The optical image provides a road map for navigating your sample in the SEM.

Step 1: Using an inverted optical microscope, examine the cross-section of the sample. Place the sample face-down on the stage (Figure 1). Use the x and y-axes controllers to move your area of interest to the center of the optical field (Figure 2).

Step 2: To examine under a scanning electron microscope, samples must be made conductive. A sputter coater is used to deposit a thin conductive layer of gold on non-conductive samples (Figure 3).

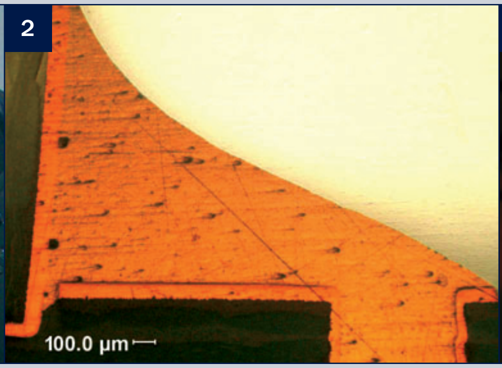
Step 3: After sputter coating, a conductive copper adhesive tape is used to bleed off any electron charge that may build up on the sample surface. Notice the metallic reflection from the surface that has been sputter coated with gold (Figure 4).

Step 4: Place the sample in holder and secure with screw. Align the screw with the copper adhesive tape for grounding purposes (Figure 5).

Step 5: Secure the holder on the stage of the SEM sample chamber and center the stage (Figure 6). Evacuate the sample chamber and wait until it reaches the required high vacuum level.

Besides providing a greater magnification, a scanning electron microscope can be used to obtain elemental information from the sample. Backscattered electrons can be used to detect different chemical compositions in the sample. Heavier elements (higher atomic number) in the sample are able to backscatter electrons more than lighter elements and appear brighter in the image. In addition, characteristic X-rays are emitted when the electron beam interacts with the sample (energy dispersive X-ray spectroscopy or EDS). This provides information on elemental quantity and composition of the sample.

Step 6: After reaching high vacuum, open the valve between the electron gun and sample chamber. In this sample, a solder joint of eutectic tin-lead (Sn63-Pb37) is being examined. The tin phase appears gray and the lead phase appears white. The bottom black



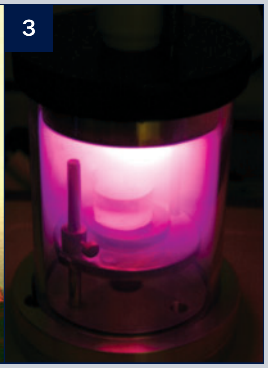


Figure 1: Epoxy mounted solder joint cross-section on inverted microscope. *Figure 2: Optical image of epoxy mounted solder joint cross-section.* *Figure 3: Sputter coating of epoxy mounted solder joint cross-section.*

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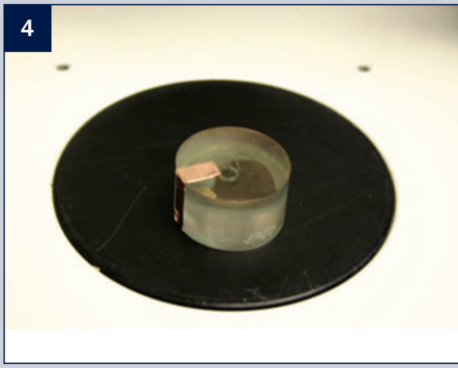

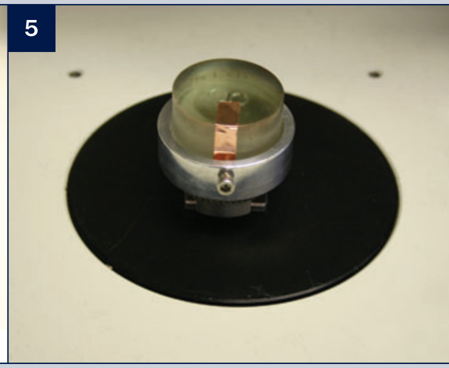

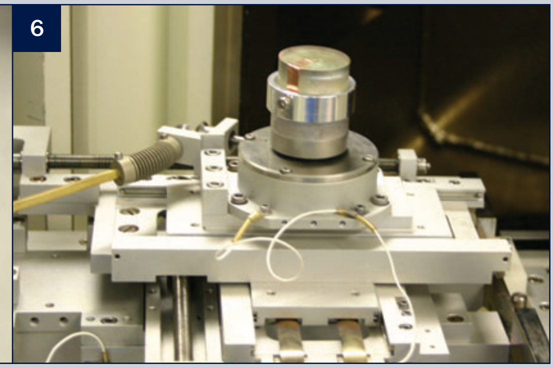

Figure 4: Copper adhesive tape on epoxy mounted solder joint cross-section. *Figure 5: Sample holder with securing screw aligned with the copper adhesive tape for grounding.* *Figure 6: Sample mounted on stage holder in SEM sample chamber.*

portion is the copper phase from the board surface mount pad. Dark gray denotes the tin-copper intermetallic layer. Using EDS, the chemical composition of the sample can be determined at a specific location (indicated by the red cross in Figure 7). In this sample, the intermetallic layer between the solder and the copper contains 59% tin, 36% copper, and 5% lead by weight.

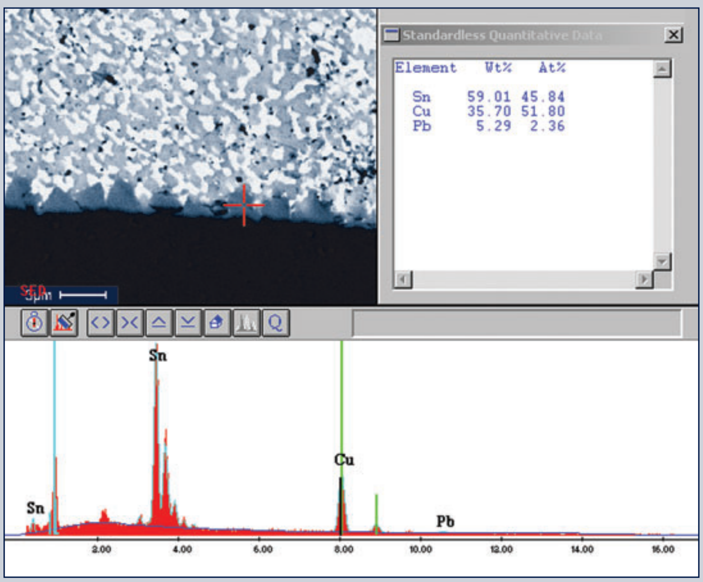

Figure 7: SEM image and EDS analysis of solder joint cross-section.

ACI Technologies has the capability and experience to perform both optical and scanning electron microscopy for failure analysis. If you would like additional information, please contact the Helpline at 610.362.1320 or visit the ACI website at www.aciusa.org.

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