



3000 Lakeside Drive, Suite 105N
Bannockburn, IL 60015-1249

IPC-TM-650 TEST METHODS MANUAL

1 Scope This method is to be used as a guideline for preparing a metallographic specimen of printed boards. The finished microsection is used for evaluating the quality of the laminate system and plated structures (plated-through holes, solder joints, vias, etc.). The plated structures can be evaluated for characteristics of the copper foils, plating, and/or coatings to determine compliance with applicable performance specification requirements.

Metallographic sample preparation is regarded by many as essentially a highly developed skill; this method describes those techniques that have been found to be generally acceptable. It does not attempt to be so specific as to not allow acceptable variations that can differentiate metallographers. Furthermore, the success of these techniques remains highly dependent upon the skill of the individual metallographer.

Note: These microsection techniques are processes and are intended as guidelines and thus variations are allowed.

Note: The use of the materials listed in Section 4 may be limited or forbidden in some environments. Please review the Safety Data Sheet (SDS) for the materials being used.

1.1 Method A (Manual) Description Manual metallographic preparation of sample(s).

1.2 Method B (Semi or Automatic) Description Semi or automatic metallographic preparation utilizing dedicated microsection equipment to prepare multiple samples.

2 Applicable Documents

IPC-MS-810 Guidelines for High Volume Microsectioning

ASTM E 3 Standard Methods of Preparation of Metallographic Specimens

3 Test Specimens A test coupon or printed board to be inspected per the applicable performance specification, which includes the features to be evaluated (i.e., plated holes or laminate). This may require multiple microsections.

4 Apparatus or Material

4.1 Sample removal method (see IPC-MS-810 for the best method to meet your needs).

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4.2 Personal Protective Equipment (e.g., eye protection, gloves)

4.3 Ventilation system (Fume Hood) in compliance with material SDS (as required)

4.4 Mount molds.

4.5 Smooth, flat mounting surface.

4.6 Release agent (optional).

4.7 Sample supports (optional for Method A).

4.8 Sample alignment tools (Method B).

4.9 Metallographic wet grinding/polishing system or equipment (as applicable).

4.10 Low magnification visual aid (reticle optional)

4.11 Metallographic microscope capable of minimum construction integrity magnifications as specified in procurement documentation.

4.12 Vacuum pump and desiccator or pressure pot (optional).

4.13 Potting material (maximum cure temperature 93 °C [200 °F]). (For discussion on selection of potting material refer to IPC-MS-810.)

4.14 Sandpaper. Federation of European Producers of Abrasives (FEPA)(ISO 6344) paper backed Silicon Carbide P (coated) abrasive medium P80-P4000 (United States CAMI (Coated Abrasive Manufacturers Institute) grit range: 80-1200.

4.15 Polishing Cloths. A hard, low, or no nap cloth for rough and intermediate polishing, and a soft, woven, or medium nap cloth for final polishing.

4.16 Oxide or colloidal silica polishing suspension (final polish, 0.3 - 0.04 µm [11.8 - 1.57 µin]). (Optional).

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4.17 Diamond polishing abrasive (6.0 - 1.0 μm [236 - 39.4 μin]).

4.18 Polishing lubricant.

4.19 Specimen etching solution (see 5.5.2.1).

4.20 Cotton balls and swabs for cleaning and etchant application.

4.21 Isopropyl alcohol, 25% methanol aqueous solution, or other suitable solvent (check for reaction with the encapsulation media and marking system).

4.22 Permanent identification marking method (e.g., laser scribing, permanent marker, embedded label, etc.) to provide traceability.

4.23 Ultrasonic cleaner (optional).

5 Procedure The procedure steps of this section are applicable to both Method A and Method B unless otherwise indicated.

5.1 Removal of Specimen Remove the required specimen(s) from the product to be tested. Allow sufficient clearance to prevent damage to the area to be examined. Some commonly used methods include sawing using a jewelers saw, miniature band saw, diamond saw or abrasive cut-off wheel; routing using a small milling machine; or punching using a sharp, hollow die (not recommended for thick or brittle materials, i.e., polyimide and some modified epoxy resin systems) (see IPC-MS-810). All samples must maintain required traceability.

5.2 Preparation of Specimen

Note: Complete any required preconditioning and/or stress testing prior to mounting.

Note: To determine correct plane of grind for plated structures with a length of 0.010 inch or less, the diameter of the structure **shall** be required for the assessment. For microvias the diameter of the structure at the capture land layer **shall** be provided. For stacked structures where both structures do not meet center of hole tolerance at the same time, refer to the performance specification for guidance or AABUS.

5.2.1 Method A Deburr all edges prior to mounting using rough grind grit in accordance with Table 5-1 to within

approximately 1.27 mm [0.05 in] of final polish depth. Ensure that the evaluation edge is parallel to the mounting surface and the sample maintains perpendicularity as shown in Figure 5-1.

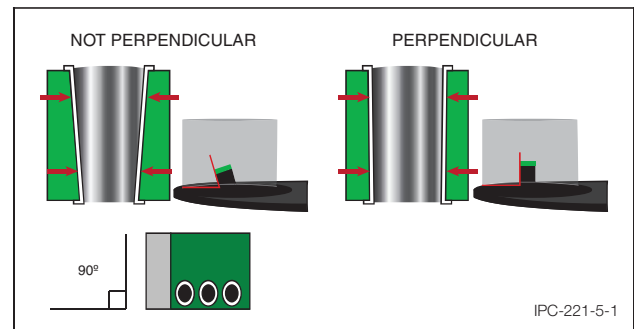


Figure 5-1 Maintaining Perpendicularity throughout the Microsection Process

5.2.2 Method B Remove the specimen from the printed board or panel such that the tooling pin holes or target PTHs are not damaged.

5.2.2.1 Inspect Tooling Pin System Inspect the tooling pin holes or slots to verify they are not plugged or damaged. Clear plugged tooling pin holes with a tool that will not change its dimensional location or enlarge the hole. A drill bit of the same hole diameter is recommended.

Inspect the tooling pins for foreign material adhering to them. Clean the pin surface as required. Discard any pins that are bent or the surface scarred.

5.3 Mounting Metallographic Sample

5.3.1 Clean mount molds and mounting surface and dry thoroughly. Apply release agent (Optional).

5.3.2 Thoroughly clean the sample using a suitable solvent such as isopropyl or ethyl alcohol. This is especially important when flux or oil is present as it may result in poor adhesion of the potting material causing gaps between the specimen and the material. These gaps make proper metallographic sample preparation extremely difficult, if not impossible.

5.3.3 Loading the Specimen

5.3.3.1 Method A Stand specimen in mount mold, perpendicular to the base using sample supports, clips, or with the

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use of double-sided adhesive tape. Keep sample in center of mount mold.

5.3.3.2 Method B Load specimen on tooling pins. The pins align the target PTHs on a common plane. This common plane assures all the PTHs will grind to the center of the hole at the same instance.

Push the tooling pins into the tooling holes or slots. The pins must fit snugly.

5.3.4 Preparing Potting Material Personal protection is recommended to prevent skin sensitization. Prepare potting material to ensure cure temperature does not exceed 93 °C [200 °F]. Mix by folding the potting material in such a way so as to minimize air bubbles.

5.3.5 Pouring Potting Material Fill the mount mold carefully with potting material, by pouring from one side to ensure adhesion to all sample surfaces.

5.3.5.1 Method A The sample must remain upright while pouring.

5.3.5.2 Method B Assure the tooling pins do not shift position or rise up while pouring and/or curing of the potting material.

5.3.6 Removal of Vacuum or Pressure for Potting Materials While in a liquid state, potting materials may require vacuum or pressure in order to achieve proper encapsulation. Remove vacuum or pressure prior to cure to prevent undue stress on the specimen.

5.3.7 Cure and Mount Removal Allow specimen to cure and cool to room temperature before removing hardened mount from mount mold. The minimum qualities the mount should exhibit are:

- The potting material is hard and not tacky.
- Minimal bubbles in the potting material.
- No gaps between the potting material and the sample.
- All gaps in structure to be evaluated should be filled with potting material.

The presence of these deficiencies will result in sample preparation difficulties, as noted in 5.3.2.

5.3.8 Marking of Specimen Identify the specimen by a permanent method (see 4.22). The selected marking system should remain unaffected by subsequent processing.

5.3.9 Mount Preparation

5.3.9.1 Method A Remove sharp edges and flatten top with low grit (240) sand paper.

5.3.9.2 Method B Remove the excess mounting material from the exposed ends of pins.

5.4 Grinding and Polishing The following is a description of the basic grinding and polishing steps. Other methods may be required by contract. See Table 5-1 for examples of 2, 3, 4, and 5-step methods for Method A and Table 5-2 and Table 5-3 for Method B.

The minimum qualities the mount **shall** exhibit are:

- 1) The grinding and polishing accuracy of the microsection **shall** be such that the viewing area of each of the PTHs is within 10% of the drilled diameter of the hole as shown in Figure 5-2.
- 2) Only fine grind scratches apparent on the mount when viewed at 100X magnification.
- 3) Little or no gap between the potting material and the specimen(s).
- 4) No residual abrasive paper grit material on the mount surface.
- 5) The ground surface has only one plane of material removal. If the mount has several planes of material removal, portions of the sample will not polish since the odd surface never touches the polishing cloth.

Note: Ultrasonic cleaning is highly recommended, especially between the finer grinding steps, prior to rough polishing and between all polishing steps. It is the nature of printed board specimens, especially those with epoxy base material following thermal exposures, to contain voids that can trap grinding and polishing residues that are not removed during simple rinsing. Care needs to be exercised not to damage the specimen surface with excessive ultrasonic cleaning. Specimen sample can be placed with the polished surface perpendicular to the bottom of the vessel. Ultrasonic cleaning for as little as one minute can damage a polished surface.