

## Metallographic Preparation of Printed Circuit Boards

The basic techniques, or mechanics, for the preparation of printed circuit boards (PCB) for metallographic examination are not too different than the preparation of most alloys found in a metallography laboratory. However, there are some differences that must be taken into consideration throughout the preparation. The thickness of the various elements or alloys used in the contact areas are extremely thin; smearing over one element with another during the sectioning and grinding operations; and over-polishing that causes relief between constituents are a few of the things the metallographer must avoid. Also the contact areas are usually quite small and the plane of the first preparation is usually the one where examination is to occur. There isn't enough material at the contact areas to afford the luxury of several re-preparations if the first preparation is unsuccessful. By exercising careful sectioning, mounting, grinding, and polishing techniques, the need for re-preparation can be eliminated entirely.

### Sectioning

Sectioning a PCB can be accomplished using any cut-off machine using abrasive cut-off wheels. However, burring is more pronounced using abrasive wheels than with diamond cut-off wheels. A cut-off machine using 4- or 5-inch diamond rimmed wafering blade is ideal for sectioning a PCB, not only because of virtually no burring but also the kerf is small and the loss of material is kept to a minimum. It is recommended that sectioning be performed slightly beyond the plane of interest, mounted, and then ground to the specific plane where metallographic examination is to be performed. If there is a possibility of sectioning being detrimental to the PCB, (fragmenting or chipping the board, or losing an area by sectioning, for instance), it is advisable to completely encapsulate the PCB first, then section. The PCB can be supported by small pieces of a cured mounting media in the mold (castable mounting only) so the PCB is in the middle of the mount. This technique eliminates the necessity of double mounting.

When rapid sampling of the plated holes on a printed circuit board is desired, an alternative to sectioning is to punch out 0.25-inch discs with the holes contained

in the middle of the disc. The hole is used as the reference point for a punch tool with a centering pin. Ten or twelve punched discs are lined up on a thin glass rod and the assembly mounted in a castable mounting media. Advantages of this method are the elimination of sectioning and more of an area of the printed circuit board can be sampled. Disadvantages are when the mounting media is setting up, internal thermal stresses have a tendency to move the aligned row of discs because the glass rod is flexible enough to allow slight bending. As a consequence, it is sometimes difficult to intersect all the holes on the diameter during the grinding operation. Also, more grinding time is required to remove the excess printed circuit board to arrive at the diameters of the plated holes. Another disadvantage is when the holes are arranged in series on the PCB, it is difficult to examine more than one or two using the punch-out method.

### Mounting

Some PCBs can be mounted in thermoplastic or thermosetting mounting media, where heat and pressure are involved, with no adverse effects. These types of PCBs usually have glass fibers for reinforcement. Other types of PCBs exhibiting brittleness must be mounted in a castable resin using a catalyst to promote hardening at room temperature. Any castable resin exhibiting good edge retention capabilities and a comparable abrasion rate to the PCB is acceptable.

### Grinding (manually)

Grinding should commence with the finest SiC grit that will remove the effects of sectioning and to arrive at the plane of interest. A 180 SiC grind will usually suffice. Grinding is carried out with a series of successively finer SiC grit sizes, usually starting with a 180 grit size followed by a 240, 320, 400, and a 600 SiC grind. Specimens should be rotated 45 or 90 degrees between the various grit sizes, and grinding should be continued until all traces of the preceding scratches are removed. It is important to always keep the specimen cool. After the final grinding step, the specimen(s) should be thoroughly cleaned with ethanol and dried with a blast of air before proceeding to the polishing steps.

## Polishing

Polishing is usually carried out in numerous steps. The first step is with a 6-micron diamond compound on a medium-to-low nap cloth, and the recommended oil extender as a lubricant. The cloth is stretched tightly over a polishing wheel and held taut by means of bands, or a PSA cloth can be used. The speed of the diamond polishing wheel should be 300 to 400 rpm using moderate pressure.

Polishing is continued until all traces of the 600 SiC grind are removed. A periodic check under a microscope is helpful in determining the progress of polishing. After the diamond polishing step is completed, the specimen is cleaned in an ultrasonic cleaner or flushed with alcohol and dried in a stream of air.

The final polishing step is with a medium (Lecloth or Imperial) napped cloth with a 0.05-micron polishing abrasive. The wheel speed should be 100 to 150 rpm. Wet the polishing wheel with water and then add the alumina polishing abrasive. Polishing is continued until all traces of the diamond polish are removed; and again, a periodic check under a microscope is helpful in determining the progress of the polish. Polish with the 0.05-micron polishing abrasive just long enough to remove the diamond scratches; prolonged polishing will have a tendency to cause relief polishing, either between the various materials comprising the contact points, or between the PCB and the mounting media.

An alternate final polishing step for contact points having gold as part of their composition is to use ferric oxide suspended in water on either a medium napped cloth or a suede cloth. The addition of a small amount of 10% chromic acid to ferric oxide slurry will facilitate polishing. With a developed technique, etching of a tin-lead layer can be achieved from the polishing wheel. Again, polishing should not be prolonged to avoid relief polishing.

## Grinding & Polishing (semi-automatic)

When there are a large number of specimens to be processed, the use of semi-automatic procedures are highly beneficial because more than one specimen can be prepared simultaneously and usually with better results. The LECO VP-160/AP-60 Semi-Automatic system with pneumatic loading is ideally suited for semi-automatic procedures. Using the mounting procedures outlined above, the specimens are cast in 1-, 1.25-, or 1.5-inch round molds. The specimens are loaded in the VP-160/AP-60 specimen holder direct from the mounting stage without any initial grinding. All grinding and polishing steps are carried out without removing the specimens from the specimen holder until ready for microscopic examination. A recommended guideline follows, however, time and pressure can vary depending upon the type of PCBs being processed.

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## Guideline for Grinding/Polishing Procedures for PCB using the LECO VP-160/AP-60 Semi-Automatic System

Grinding (SiC Grit)	Wheel Speed (rpm)	Time (sec.)	Force-Pounds
180	300-400	60	40
320	300-400	20-30	40
600	300-400	20-30	40
<b>Polishing</b>			
6-micron diamond on nylon cloth, lapping oil extender	200	60	30
0.05-micron Al <sub>2</sub> O <sub>3</sub> Lecloth™, water lubricant	100	20-60	20

## Grinding & Polishing (automatic)

When the volume of specimens to be prepared is quite large, (i.e. 100 to 200 per day), the LECO GPX300 Automatic Polisher is advantageous. Almost twice as many mounts can be processed in the same amount of time, for instance, twelve 1-inch mounts, nine 1¼-inch mounts or six 1½-inch mounts. Recommended guidelines for the grinding/polishing parameters for the GPX300 are contained in the following table.

## Guideline for Grinding/Polishing Procedures for PCB using the LECO GPX300

Grinding (SiC Grit)	Wheel Speed (rpm)	Time (sec.)	Force (lb.)
180	300	60	40
320	300	30	40
600	300	30	40
<b>Polishing</b>			
1-micron diamond/red felt/oil	200	30	40
0.05-micron gamma alumina/Lecloth™/water	150	20	34

The advantages of automatic procedures are (1) multiple specimens can be processed simultaneously, (2) edge flatness is maintained, and (3) the final result is usually better than by manual preparation.

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