TECHNotes

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Automated Microsectioning of Printed Wiring Boards

Introduction:

Microsectioning has become a standard requirement of printed wiring board (PWB) quality assurance due to the potential for hidden, subsurface defects and for process control. Increasingly, PWB manufacturers require certified vendors to perform statistical sampling of their products. As demand grows, manual microsectioning capabilities can struggle to handle the required volume of coupon cross-sectioning effectively. This necessitates automation in microsectioning. Discover the advantages of automation in our comprehensive analysis of manual vs. automated microsectioning of PWBs. Learn how automation can enhance efficiency and precision in your processes.

What is Microsectioning?

Microsectioning is a destructive technique used to evaluate PWB quality by exposing a cross-sectional view of the microstructure at a selected plane. This plane is usually located at the center of a plated throughhole, or via. Due to the destructive nature of microsectioning, test coupons are generally used. These standardized coupons are typically taken from otherwise unused areas of production panels. As a result, they undergo the same processing steps as the boards, and they are, therefore, statistically representative of the overall panel.

Removal of coupons from the production panel can be accomplished in a number of ways. One of the more common means of extraction is the punch and die method. This method utilizes a shearing force to punch the coupon from the surrounding material. For relatively thin boards, this method provides a fast means of coupon removal with minimal disruption to the integrity of the coupon. For thicker boards, a diamond saw such as the ISOMET® 1000, with Table Saw accessory, is a fast, low deformation means of coupon removal. See Figure 1.

Figure 1. *Figure 2. IsoMet® 1000 Precision Sectioning Saw with Table Saw accessory effectively sections or trims printed circuit boards*

The first step in microsectioning is to encapsulate the coupons in a protective resin. This resin material is critical since it supports the plated and solder-coated structures during the cross-sectional preparation process. For medium to high volume coupon preparation, acrylic mounting compounds are typically used for their fast curing capabilities. Once mounted, the coupon is ground and polished to the centerline of the through-hole. Cross-sectioning in the close vicinity of the through-hole centerline is critical, as it allows statistically accurate plating thickness measurements to be taken.

Microsectioning Requirements

Microsectioning of a test coupon usually has two requirements: (1) The first is that the finished crosssection must be representative of the true structure. This means that proper grinding and polishing procedures must be followed so that deformation produced during each step in the process is reduced by subsequent steps, until virtually no deformation remains; (2) The second requirement is that there must be minimal sample orientation error. Sample orientation error occurs in two forms: Tilt Error and Planar Error.

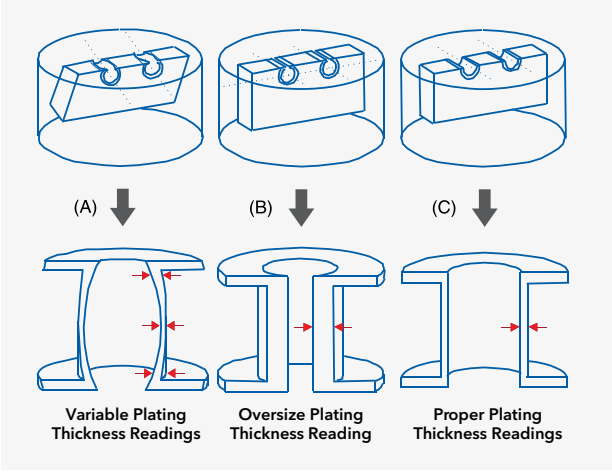

Figure 2. *Illustration A shows the results of tilt error. Plating thickness appears to vary. Illustration B shows the results of planar error. Plating thickness is exaggerated. Illustration C represents a properly perpared section.*

• Tilt error is the failure to produce a finished cross-section parallel to the centerline of the target through-hole or via. The result is a perceived variation in plating thickness from one end of the through-hole to the other, where one might not exist.

• Planar error is the failure to produce a finished cross-section within ±10% of the hole diameter from the centerline of the target through-hole or via. This causes a misrepresentation of the true plating thickness, as illustrated in Figure 3. Plating thickness appearance becomes exaggerated as the plane of sectioning moves farther from the centerline of the hole.

Let us now consider various options for producing microsections in quantity.

Manual Microsectioning

For laboratories that prepare fewer than 10-20 coupons per day, manual microsectioning may be appropriate.

When preparing a microsection, there is a significant time and cost advantage to preparing more than one coupon per mount With manual microsectioning, however, the problem is the inability to precisely align target through-holes in more than one coupon at a time. These through-holes must be aligned exactly so that the preparation process results in a section near the centerline of the target through-holes in every coupon. Once aligned, resin must be cast around the coupons without causing misalignment.

Because this is such a difficult task, most laboratories, which produce microsections manually, generally produce one coupon per mount to avoid potential problems. This results in loss of throughput, and high consumables cost.

In addition, manual preparation assumes that whomever produces the sections will hand grind them accurately and consistently, with no alignment error. Because sectioning requires regular inspection during the preparation process, and an experienced eye is needed to detect tilt and planar errors even when appropriate microscopic techniques are used. This regular need for inspection results in long preparation times for manual methods.

Increasing efficiency for manual preparation is possible by grinding one sample at a time and batch polishing. This entails performing the grinding stages for each sample consecutively until all are ground to the area of interest. Subsequent polishing is performed on several ground samples at one time.

Automated Microsectioning

As production volume increases, automation of the preparation process becomes essential. Automation not only yields considerable increase in throughput, but the quality of prepared samples is more consistent and the potential for repetitive motion injury associated with manual preparation is eliminated.

Today's automated preparation options are easy to use and available in two designs.

PC-Met® Precision High Volume Printed Wiring Board Accessory

The PC-Met Precision High-Volume Accessory involves pinning multiple coupons together in each mold. All coupons in the mold are referenced from the same pins. These kits are capable of cross-sectioning 36 coupons in the same procedure. Target accuracy for this kit is feature diameter in the range of 0.004" to 0.006" and larger. Six quick-adjust stops ensure that grinding does not proceed beyond the pre-set area of interest. Three stops are mono-crystalline diamond, three are tungsten carbide. Stops are continuously adjustable so they can be re-zeroed as they wear over time and to accommodate different coupon dimensions.

PWB Met® Small Hole Accessory

The PWB-Met Small-Hole Accessory is designed such that each coupon is referenced from its own set of pins. Pins in this case are shorter (9.5mm vs. 27mm for the high-volume kit), and polycrystalline diamond stops are used for all six stops which exhibit less wear during use than carbide stops. This design enables targeting of features as small as 0.003" to 0.004" within 10% of feature diameter.

Components within each of the two accessories are easily replaced when worn, therefore the useful life of either accessory is practically indefinite with proper care.

Each of these accessories is used in the same manner with respect to molding, grinding and polishing. Preparation is performed in a four-step procedure. Initial grinding at 180-grit CarbiMet until the "high" stops are reached. 400-grit CarbiMet until the "low" stops. Following this, 3-micron MetaDi Supreme diamond suspension on TexMet C polishing cloth for 2:30, 0.05-micron MasterPrep on MicroCloth polishing cloth for 1:30. Polished samples are quickly removed from the accessory using the PWB sample extractor.

How to Setup the PWB Accessories - Four Step Process

Step 1. *The sectioned board samples are loaded onto the alignment pins using Buehler's proprietary no-stress press*

Step 2. *Pinned samples are placed in the carrier cavities and held in position magnetically to prevent movement during casting*

Step 3. *The mold cover is positioned over the samples and SamplKwick® Mounting Compound ispoured. Samples are then ground and polished.*

Step 4. *After the preparation is completed the samples can be removed and optically examined.*

Table 1. PWB Grinding Method

Step	Surface	Abrasive	Lubricant	Force Total	Time (min:sec)	Platen Speed (rpm)	Head Speed (rpm)	Rotation
1	CarbiMet PSA	120 grit	Water	35lbs	2:00	300	150	Comp
2	CarbiMet PSA	180 grit	Water	35lbs	1:30	250	150	Comp
3	CarbiMet PSA	400 grit	Water	30lbs	2:00	250	150	Comp
4	TexMet C	3µm MetaDi Diamond	NA	30lbs	2:45	250	150	Comp
5	MicroCloth	0.05µm MasterPrep	NA	30lbs	0:45	200	150	Contra

Cost and Time Savings

- Automated accessories for PWB cross-sectioning enable accurate, reproducible cross-sectioning of thousands of coupons per month. When comparing consumables used for manual preparation relative to automation, we can quickly realize considerable cost savings.
- Grinding of 36 mounted coupon samples can typically be done using one sheet of silicon carbide paper per grinding step. When manually grinding one sample we could certainly use the same paper multiple times, however it will be worn out long before we grind 36 samples manually. Silicon carbide paper cost is likely to be reduced by more than half.
- Cost savings during automated polishing are likely higher than for grinding. Automated polishing time is very short compared to manual polishing (in no small part due to reduced relative rotation with lack of rotating power head when manual polishing). Diamond abrasive is applied to polishing cloths throughout whether using automation or manual polishing. It is likely a comparable amount of diamond is used to polish one coupon manually as 36 coupons using automation, resulting in cost savings on diamond suspension of over 30 times. Though more difficult to quantify, there are further cost savings in use of polishing cloths for automated procedures.
- Labor costs associated with sample preparation will vary considerably depending on many factors. To compare automated procedures to manual, one need only realize that with automated accessories we can prepare 36 coupons in about ten minutes and compare that to the time an operator must spend preparing one.
- Finally, automation removes variability inherent to manual preparation, eliminating re-work and potential questions of whether observations in the microscope could be related to the preparation process or from the manufacture of the board. Further, the automated accessories ensure that preparation quality meets IPC and mil-spec standards.
- Buehler's printed wiring board accessories have enabled board manufacturers to maximize production volume while ensuring the highest quality for over 40 years. These accessories have evolved over the years to meet the increasing demand to target smaller features with a high degree of accuracy. Buehler's high-volume and small-hole accessories are the most convenient products on the market today. This, combined with the fact that the components of these kits are readily replaced when worn (no need to purchase a replacement accessory), makes the Buehler printed wiring board accessories the best value for high-volume sample preparation.

For more information on Buehler's automated solutions, visit our webpage:

https://www.buehler.com/products/grinding-and-polishing/grinding-and-polishing-consumables/pc-met-and-pwb-met-electronic-solutions/

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