



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES®

IPC-MS-810

Guidelines for High Volume Microsection

IPC-MS-810

Original Publication -
October 1993

A standard developed by IPC

2215 Sanders Road, Northbrook, IL 60062-6135

Tel. 847.509.9700 Fax 847.509.0700
www.ipc.org



Documents
Document Sharing Hub

The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

Notice

IPC Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or nonmember of IPC from manufacturing or selling products not conforming to such Standards and Publication, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than IPC members, whether the standard is to be used either domestically or internationally.

Recommended Standards and Publications are adopted by IPC without regard to whether their adoption may involve patents on articles, materials, or processes. By such action, IPC does not assume any liability to any patent owner, nor do they assume any obligation whatever to parties adopting the Recommended Standard or Publication. Users are also wholly responsible for protecting themselves against all claims of liabilities for patent infringement.

IPC Position Statement on Specification Revision Change

It is the position of IPC's Technical Activities Executive Committee (TAEC) that the use and implementation of IPC publications is voluntary and is part of a relationship entered into by customer and supplier. When an IPC standard/guideline is updated and a new revision is published, it is the opinion of the TAEC that the use of the new revision as part of an existing relationship is not automatic unless required by the contract. The TAEC recommends the use of the latest revision.

Adopted October 6, 1998

Why is there a charge for this standard?

Your purchase of this document contributes to the ongoing development of new and updated industry standards. Standards allow manufacturers, customers, and suppliers to understand one another better. Standards allow manufacturers greater efficiencies when they can set up their processes to meet industry standards, allowing them to offer their customers lower costs.

IPC spends hundreds of thousands of dollars annually to support IPC's volunteers in the standards development process. There are many rounds of drafts sent out for review and the committees spend hundreds of hours in review and development. IPC's staff attends and participates in committee activities, typesets and circulates document drafts, and follows all necessary procedures to qualify for ANSI approval.

IPC's membership dues have been kept low in order to allow as many companies as possible to participate. Therefore, the standards revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards, why not take advantage of this and the many other benefits of IPC membership as well? For more information on membership in IPC, please visit www.ipc.org or call 847/790-5372.

Thank you for your continued support.



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES®

IPC-MS-810

Guidelines for High Volume Microsection

Developed by the Automatic Microsectioning Task Group (7-10b)
of the Testing Committee (7-10) of IPC

Users of this standard are encouraged to participate in the
development of future revisions.

Contact:

IPC
2215 Sanders Road
Northbrook, Illinois
60062-6135
Tel 847 509.9700
Fax 847 509.9798



Documents
Document Sharing Hub

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the IPC Automatic Microsectioning Task Group of the IPC Testing Committee are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Testing Committee	Automatic Microsectioning Task Group	Technical Liaison of the IPC Board of Directors
Chairman Tom Turner ADI/Isola	Chairman Randy Reed Texas Instruments	Robert Scott Phase II

Automatic Microsectioning Task Group

B. L. Amsbury, Hughes Aircraft	P. E. Hinton, Hinton Engineering	N. Preimesberger, Hughes Aircraft Co.
R. E. Beauchamp, General Electric	D. L. Holland, Lockheed Sanders Inc.	E. Pujol, Delsen Testing Labs
C. Boggs, Phase II	R. D. Hott, Robison Laboratory Inc.	P. J. Quinn, General Electric Co.
S. T. Bora, Smiths Industries	M. W. Jawitz, Litton Guidance & Control Systems	P. J. Reardon, Rogers Corp.
J. F. D'Andrea, General Electric Co.	C. Kemp, General Electric Co.	J. Roberts, Rockwell International
T. F. Dawson, Charles Stark Draper Labs	S. Korchynsky, Federal Systems Co.	D. E. Robertson, Pace Inc.
A. C. Dentino, Acton	V. Kumar, Martin-Marietta Electronics	P. B. Rose, Martin-Marietta Electronics
M. J. Di Franza, Mitre	S. Mansilla, Robisan Laboratory Inc.	K. Selk, TRW
C. D. Dupriest, Loral Vought Systems	R. Martinez, Magnavox	G. A. Smith, Trace Laboratories - East
F. Durso, MacDermid Inc.	B. C. McCrory, Delsen Testing Labs	K. Thorson, Paramax Systems Corp.
A. F. Eaton, Sundstrand Aerospace	J. L. Mulcahy, Methode Electronics Inc. East	T. Turner, ADI/Isola
L. E. Fesser, Paramax Systems Corp.	W. Pfefer, Dornier GmbH	N. Vermani, Paramax Systems Corp.
P. Gildehaus, Allied Signal Aerospace	W. Phillipson, Buehler Ltd.	J. E. Voytko, Sandia National Labs
S. Glancy, Struehers Inc.		
T. S. Grover, Hughes Aircraft Co.		
D. D. Hillman, Rockwell International		



Table of Contents

1	SCOPE	1	9.18	Target Plated-Through Hole.....	15
2	APPLICABLE DOCUMENTS	1	9.19	Tooling Edge, Mount	15
2.1	IPC.....	1	9.20	Tooling Holes, Microsection.....	15
3	SAMPLE REMOVAL PROCESS	1	9.21	Tooling Pins, Microsection	15
3.1	Sample Location.....	1	10	REFERENCES	15
3.2	Removal Method.....	1	11	RECOMMENDED READING	15
4	MOUNT PROCESS	2	12	ILLUSTRATIONS	15
4.1	Sample Orientation.....	2			
4.2	Tooling System.....	3		Figures	
4.3	Mounting	4	Figure 1a	Planar distortion	16
4.4	Mount Process Quality.....	5	Figure 1b	Center line integrity	16
5	GRIND PROCESS	5	Figure 2	Target holes in same axis	17
5.1	Equipment.....	5	Figure 3	Gaps between mounting material and samples	17
5.2	Tooling.....	6	Figure 4	Depression in mounting material	17
5.3	Tool Stops.....	7	Figure 5	Effects of mechanical grinding and polishing.....	18
5.4	Consumables.....	8	Figure 6	Perpendicularity of motor to sandpaper disc assembly	18
5.5	Grind Process Quality	9	Figure 7	Position of mount holder on sandpaper disc	19
6	POLISH PROCESS	9	Figure 8	Reference Zero relationship between target holes and tooling edge.....	19
6.1	Equipment.....	9	Figure 9	Mount Holder Collar: Effects of Deflection.....	20
6.2	Tooling.....	10	Figure 10	Effect of wear depression on mount holders	20
6.3	Consumables	10	Figure 11	Balanced Mount Holder.....	21
6.4	Cleanliness.....	12	Figure 12	Carbide pad flatness and height.....	21
6.5	Polish Process Quality	13	Figure 13	Carbide pad should be center on arc	22
7	MICRO-ETCHING	13	Figure 14	Leaf cut effect.....	22
7.1	Application Methods	13	Figure 15	Abrasive paper grit size (American vs. European)	23
7.2	Types.....	13	Figure 16	Effect of trash trapped between mount holder and tooling edge	24
8	TROUBLESHOOT GUIDE	13	Figure 17a	Acceptable polish quality.....	25
9	GLOSSARY	14	Figure 17b	Acceptable polish quality.....	25
9.1	Abrasion.....	14	Figure 18a	Samples above potting material.....	25
9.2	Charging	14	Figure 18b	Samples above potting material	25
9.3	Coupon Test Strip.....	14	Figure 19a	Rounding at copper plate and solder interface.....	26
9.4	Crescent Moon Scratch	14	Figure 19b	Rounding at copper plate and solder interface on the surface	26
9.5	Grind.....	14	Figure 20	Scratch deformation	26
9.6	Grinding Wheel	14	Figure 21	Smeared metal	26
9.7	Grit Size.....	14	Figure 22	Contact area comparison – sandpaper vs. polish cloth.....	27
9.8	Grind Mount Holder	14	Figure 23	Crescent moon scratch pattern.....	27
9.9	Micro Etchant.....	14			
9.10	Mounting	14		Tables	
9.11	Polish Mount Holder.....	14	Table 1	Mounting Material Characteristics.....	5
9.12	Polish	14	Table 2	Etchant Types.....	14
9.13	Sample Removal	14		Troubleshoot Guide.....	15
9.14	Scratch	14			
9.15	Scratch Trace	14			
9.16	Speed Bump	14			
9.17	Stops, Tooling	15			

Guidelines for High Volume Microsection

1 SCOPE

High volume microsection is a process. These guidelines discuss the many variables and problems associated with the process from sample removal to micro-etch. The guidelines do not promote any one vendor's process, but discuss the variables common to high volume microsection.

The process variables and problems are organized so the reader can research a specific issue or overview the variables of a process area.

2 APPLICABLE DOCUMENTS

2.1 IPC

IPC-D-275 Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies

IPC-T-50 Terms and Definitions for Interconnecting and Packaging Electronic Circuits

3 SAMPLE REMOVAL PROCESS

3.1 Sample Location

3.1.1 Coupon Test Strip Companies generally use a "home grown" or military conformance coupon for microsection inspection. IPC-D-275 outlines the attributes a coupon test strip should exhibit based on the product type being built.

Benefits:

- Production parts are not lost due to microsection testing.
- The internal and external features are the same from panel to panel to facilitate SPC data collection.
- The strips may be used to screen product as required.
- The customer can correlate to your microsection results easier because you both sample in the same location on the same test design.

Drawbacks:

- Space is lost on the panel that could be used to build parts.
- The test strip may not be representative of the associated part.

3.1.2 Part The actual production parts are used for microsection inspection.

Benefits:

- Space is not wasted on the panel due to test strips.

- There are no paneling constraints that dictate where the test strip must be placed to preserve part correlation.
- There is less of an issue over how representative the test strip is to the associated part.

Drawbacks:

- Microsection inspection of parts may not be cost effective for product with a high unit cost.
- For MLBs, multiple samples are usually microsectioned to inspect all the inner layer connections for each panel. These multiple samples can significantly increase the sample plan.
- The test results may not agree with the customer's results because microsections were taken on different locations of the part. This can only be resolved by providing the part sample locations to the customer.

3.2 Removal Method Regardless the method chosen, the cutting edge should remain a minimum of 0.25 cm [0.100 in] from the edge of the target plated-through-hole (PTH) pads. This is to prevent cutting deformation causing damage to the sample which may lead to false failures. The only exception to this guideline is abrasive cut-off wheels.

3.2.1 Fracturing This method is usually used in conjunction with routing to remove samples from brittle material (i.e., polyimide). The sample is routed leaving a finger tab that holds the sample in the panel. Fracturing is when the operator pushes or cuts the sample out of the panel by breaking the finger tab. The benefits and drawbacks of routing will be discussed in that section.

Benefits:

- The samples are routed and remain with the panel. This resolves panel traceability issues when the actual sample is not serialized.
- The samples, test strip, and parts are routed at one time. This prevents unnecessary use of costly production routers to only rout the sample.

Drawbacks:

- The finger tabs width needs to be optimized to keep the sample in the test strip during handling and permit an operator to push the sample out. The tab width may be different for families of products and/or board thickness. Thick boards may require needle nose pliers (or equivalent) to break the finger tabs.
- The location of the tab needs to be as far from the target PTHs and microsection tooling holes as possible. This will minimize the likelihood that material stresses will be transferred to the sample when it is pushed out.

3.2.2 Punching This method removes the sample by using a die to punch the sample out of the panel. The die must be hollow so that it never comes in contact with the target PTHs. The force that pushes the die through the panel may be pneumatic or manual (kick or leverage) method. This method of sample removal is not recommended for brittle materials.

All cuts must be made with a fast, smooth, and strong motion. This requires periodic maintenance to keep the die sharp and the ram properly aligned and well oiled.

Benefits:

- This method quickly removes the sample.
- No rout programs or cams are required to remove the sample.
- No pin-up holes are required to provide a reference point to remove the sample.

Drawbacks:

- The dies can quickly cause a great deal of damage to the test sample when not properly maintained. The sharpness of the die can be monitored by setting limits on how much crazing the edge of the sample is permitted. The recommended limits is no more than 0.025 cm [0.010 in] from the sample's edge at 10X magnification.
- This method is limited by the board thickness. The maximum board thickness this method is recommended for is 0.125 inch using pneumatic system and 0.25 cm [0.100 in] using the manual method.
- Do not punch brittle material (i.e., polyimide). The shock damage will cause false defects to appear in the sample. The primary concern is laminate defects.

3.2.3 Sawing This method removes the sample using a jewelers saw or miniature band saw.

3.2.4 Abrasive Cut-Off Wheels The sample is removed by a silicon carbide, aluminum oxide, or diamond rimmed blade. This method has the lowest opportunity for sample deformation but it also has the longest cycle time. This is the only method that can cut close (under the 0.25 cm [0.100 in] limitation) to the target PTH pads without damaging them.

Benefits:

- The method has the lowest sample deformation opportunity of all methods.
- There are no limitations on board thickness or material type the sample can be removed from.

Drawbacks:

- This method is too slow when the required number of microsections is greater than 200 samples per day.
- The saw can only cut in a straight line. This limitation may cut test strips in half causing traceability problems

and/or require multiple runs to cut the sample to the desired size.

- The lubricant used to cool the saw adds an extra operation to the microsection process. The lubricant must be cleansed from the samples before bake or solder float depending on your microsection methodology.

3.2.5 Rout This method uses a small milling machine or production routers used by the shop to remove the samples.

Benefits:

- The board thickness limitations are not as strict as some of the other methods.
- The method removes brittle samples without causing mechanical damage.

Drawbacks:

- The rout operation set-up time for each run is lengthy. The router must be able to rout multiple test strips (10 or more) within each run to be time efficient. The small milling machine and pin routers usually only rout one test strip at a time.
- Reference zero for the rout cam or program that controls the router bit are defined by pin-up holes. These pin-up holes are available when the sample is routed in panel form, PTHs within the part, or target PTHs in the test strip. If the target PTHs are used, care must be taken that no mechanical stresses are transferred to these holes during the rout sequence.
- The rout routine must not dwell in the same location too long. The router bit will generate a great deal of heat which will cause sample deformation. This becomes more critical as the board thickness is larger. The patterns that generate the highest amount heat are square corners and tight radius turns.
- Beware that the vacuum system cannot swallow the samples. Precautions need to be taken to prevent this circumstance.

4 MOUNT PROCESS

The samples are mounted in a potting material. The mounts must exhibit certain characteristics for microsection process to be successful. These characteristics are:

- Holes to be microsectioned (Target Holes) must be in the same axis.
- One type of material potted in a mount.
- Potting material and sample material are comparable hardness.
- No gaps or depressions in the potting material.

4.1 Sample Orientation

4.1.1 Same Product Type Within A Mount The same product type should be within a mount. Mixing product

types (i.e., MLB and flex) may cause portions of the mount to grind faster than others. When the unequal grinding is extreme, the mount will not have a flat surface. The portion that is not flat will have scratch problems during the polish process.

4.1.2 Samples Should Not Touch There should be a minimum spacing between the samples. The recommended distance is 0.025 to 0.157 cm [0.010 to 0.062 in]. This space allows the mounting material to support all the surface features of the samples and prevent false failures (i.e., lifted lands).

4.1.3 Sample Orientation The samples should be orientated in the mount so the first sample is easily distinguishable. This will enable the operator to use the chosen traceability system to report results. The samples also may be orientated so that layer one is in the same direction.

4.1.4 Traceability A system needs to be developed to trace each sample back to its associated panel and/or part. This requires traceability not only within the mount but also from mount to mount. Marking methods for the mount are external labels, embedded labels, mechanical scribing, and permanent ink markers. The type of label chosen must be compatible with lubricants, solvents, abrasive, and etchants the mount is exposed to during processing.

The use of a 'standard' coupon pinning scheme, computer processing, or bar code labeling can be used as alternatives to the standard marking methods. A tremendous amount of time can be saved by using a well documented and integrated traceability system.

4.2 Tooling System The tooling holes, tooling pins, and molds are the heart of the high volume microsection system. The tooling pins are placed in the tooling holes to align the target plated-through-holes (PTHs) in the same axis. This alignment increases the likelihood the grinding process stops at the centerline of all the target PTHs at the same instance.

4.2.1 Holes Drilled at Drill Process

4.2.1.1 Misdrills Audit the location of the tooling holes with a template or X-Y coordinate machine. The audit should only be done when problems are suspected.

4.2.1.2 Sample Removal Damage There should be a minimum of 0.127 cm [0.050 in] of material between the tooling hole edge and edge of the sample. This will prevent tooling hole damage that will allow the sample to move during the cure of the potting material.

4.2.1.3 Plugged Holes Inspect the tooling holes to ensure no solder or debris is plugging them. If the holes are plugged, remove the obstruction with a hand held drill bit. Do not use a tool that will enlarge or 'egg-shape' the tooling hole.

4.2.2 Tooling Pins

4.2.2.1 Pins Fit Tight The tooling pins must fit tight in the tooling holes. Any play in the holes will translate to the distance the grind process will miss the centerline of the target PTHs. Also a loose fit can cause the samples to hang at an angle (planar distortion) instead of straight down. "Planar distortion will cause an overestimation of the plating thickness which will be significantly increased when combined with the center of the hole tolerance." See Figure 1.

4.2.2.2 Pin Positioning The pins should be equal length on each side of the first sample and last sample. This helps to ensure the samples are mounted in the center of the mold. The samples should not be skewed to the side of the mount.

4.2.2.3 Flush to Mount Tooling Edge (See Figure 8) The tooling pins are placed on the mount mold edge or on pads attached to the grind mount holder. The mount edge dimensions the distance from the centerline of the tooling holes to the target PTHs. A system must be developed to assure the pins remain in contact with the edge during the mounting process. Some current methods are weights, metal clips, and physical stops that hold the pins in place.

4.2.3 Mounting Molds

4.2.3.1 Sample Positioning The samples should not be skewed to one side of the mount. The minimum distance the sample should be from the mount edge is 0.078 cm [0.031 in]. Samples at or near the mount edge tend to grind/polish unevenly. Also the sample external features are not supported to prevent false failures due to microsection damage.

4.2.3.2 Construction Permits Exothermal Reaction

The potting material cures by an exothermal reaction. The mount must be constructed of material that efficiently transfers heat from the curing potting material to the atmosphere. Recommended mold construction materials are stainless steel, aluminum, and plastics. If the mold insulates the exothermal reaction, the cure will take longer which may have an adverse effect on the mount material's hardness and increase the likelihood of false failures.

4.2.3.3 Mount Tooling Edge

The mount will have an edge or pad that specifies the distance from the centerline of the tooling holes to the target PTHs. This is the critical dimension that determines the amount of material that must be removed by the microsection process. This edge must be kept clean from buildup and free of surface damage (i.e., dents, scratches, nicks).



4.3 Mounting The encapsulation of the test samples in potting material is necessary to ensure edge retention of the surface features and prevent mechanical forces of grinding to be transferred to the sample's PTH barrel.

4.3.1 Methods

4.3.1.1 Room Temperature Cure The potting material cures due to an exothermic reaction of the material. The rate of cure is dependent on the ratio of the resin and hardener, and the ability of the mold to transfer the heat away from the potting material.

4.3.1.2 Compression Molding This technique cures the potting material using high temperatures and pressure. The method is not recommended because the opportunity for creating false failures is too great.

4.3.1.3 Vacuum Assist Vacuum assist is a specialized method to help room temperature cure resins to flow more easily into small diameter plated-through-holes.

4.3.1.4 Oven Cure Some of the epoxies and polyesters have long cure times. These longer cure times are caused by a low exothermal reaction during curing. The oven cure method was developed to artificially add heat to accelerate the cure reaction thus shortening the cure time. Caution: Be sensitive to the cure temperature of the resin (See MOUNTING: Material Characteristics – Cure Temperature).

4.3.1.5 Low Pressure Potting This technique cures the potting material at room temperature under low pressure (less than 7 kg per sq. cm). Samples are cured in a pressure vessel using the same potting material as room temperature cure (4.3.1.1). The technique improves flow of material into small holes and will provide a cleaner polymer to aid in microsection inspection.

4.3.2 Mounting Material

4.3.2.1 Characteristics These are the various potting material characteristics required to support the needs of high volume microsection. Some of these traits are common to microsectioning and others are unique to the high volume method. Often one mounting material will not meet every requirement. Selection of a potting material depends on each lab's unique needs.

4.3.2.1.1 Sample Surface Cleanliness The surface must be free of all contaminants that may act as a release agent to the mounting material. Common sources of contamination are flux, abrasive cut-off wheel lubricant, water, plating solutions, oils, hand lotions, and grease. The cleaning

process needs to be tailored to the contaminant that must be removed.

4.3.2.1.2 Hardness The cured hardness needs to closely match or exceed the hardness of the embedded samples. When the potting material is softer, there is a tendency for this material to be removed faster than the samples feeling like ridges higher than the mount material after polish (speed bumps). See Figure 18. This problem inhibits the accurate reading of surface dimensions and causes inaccurate inspection results of surface features (i.e., lifted lands).

4.3.2.1.3 Low Shrinkage Shrinkage is the amount the material contracts due to curing. High shrink rates (contraction forces) can be severe enough to bend tooling pins, move the samples within the mount, reduce the diameter of the mount, change the location of the reference edge on the mount. Any sample movement during the potting material cure can be disastrous to the grind process capability to stop at the centerline of all the target PTHs.

4.3.2.1.4 Low Viscosity The material must have a low viscosity after mixing to allow the liquid to flow freely around the samples. The low viscosity is especially important when it must fill small diameter PTHs (0.015 inch diameter or less). When a low viscosity is not practical, the flow of the mounting material can be facilitated by placing the mount in a vacuum environment.

4.3.2.1.5 Cure Temperature The cure temperature should not exceed 93°C [200°F] unless the material has a cure time of 1 hour or more. Temperatures above 93°C [200°F] may cause laminate failures that would not normally be present. The recommended cure temperature is 60°C to 71°C [140°F to 160°F].

4.3.2.1.6 Chemical Resistant The mount material must be able to withstand the lubricants, etchants, polish media without softening, voiding, or cracking.

4.3.2.1.7 Easy to Mix Many of the above characteristics are based on how the material is mixed from batch to batch. A system for measuring component volume is recommended to ensure reproducible curing characteristics. This can be accomplished using a pneumatic dispensing system, pipette, or scale. Whatever method chosen should be audited regularly and monitored by SPC. This single process along with thermal stress can cause more false failures than any other step of the microsection process.

4.3.2.2 Types

4.3.2.3 Material Problems Most material problems are related to poor mounting material quality, improper exotherm of the curing reaction, or improper mixing.

Table 1 Mounting Material Characteristics

Acrylics	Epoxies	Polyesters
High Shrinkage	Low Shrinkage	Low Shrinkage
Variable Exotherm	Variable Exotherm	Variable Exotherm
Rapid Cure	Slow Cure	Slow Cure
Translucent	Semi-Transparent	Transparent
Moderate Hardness	Moderate Hardness	Fair Hardness
Solvent Sensitive	Solvent Resistant (dependent on mix ratios)	Solvent Sensitive

the mounting material. Cure temperature testing prior to use can eliminate the introduction of inferior material into the microsectioning process. Mixing problems can be prevented by technician training and the use of proper measuring equipment (scale, pipette, graduated container, etc.).

If acrylic mounting material has problems with poor edge retention and severe rounding, add 1 micron alumina to the mixture ratio to reduce the effect. The 1 micron alumina should not exceed 10% of the mix ratio. Do not reduce the other components of the mix ratio when adding alumina.

4.4 Mount Process Quality

4.4.1 Target PTHs in the Same Axis (Figure 2) The target holes are the plated-through-holes that are to be microsectioned for evaluation. The centerline of the holes must be in the same axis from sample to sample. This assures the target PTHs are ground and polish to the same depth in the holes.

The grind/polish process will not correct any axis problems in the mount. As the old saying goes “Junk in, junk out.”

4.4.2 No Gaps on the Mount or Sample Any gaps on the surface acts like a debris trap. These debris traps make the cleanliness requirements between polish steps tougher to accomplish. Cleanliness is required to ensure the cloths are not contaminated with debris that will cause unwanted scratches. Common gaps are:

- ‘Target Holes’ are not 100% filled. They must have mounting material, bonding material, copper, solder, etc. in the hole (See Figure 3).
- Gap between the mounting material and samples. These gaps trap debris that will ooze out on the finished sample. This gap will cause the most problems (See Figure 3).
- Depressions in the mounting material. These are evident after the grind sequence. These gaps make the cleanliness in the polish sequences troublesome (See Figure 4).

5 GRIND PROCESS

Grind variables can be generalized into the following categories: equipment, tooling system, and the consumables.

The grind operation removes material to a location short of the center of the target plated-through hole (PTH). This leaves room for the polish process to remove the scratches and deformation from the grind process. The minimum distance recommended is 0.025 mm [0.001 in]. The maximum is dependent upon the size of the PTH and abrasive paper grit size of the final grind step.

Gunter Petzow in *Metallographic Etching* states “scratches, sample deformation, and smearing are characteristic consequences of mechanical grinding and polishing.” Sample deformation and scratches are prevalent during coarse grinding. The effects of these consequences on the sample surface are shown in Figure 5.

5.1 Equipment The materials microsectioned will dictate the type of equipment needed. All the systems have advantages and disadvantages. Special items to be considered when purchasing a system are:

- Hardmount Tooling System
- Potting Material Type
- Throughput volume (# sample/day)
- Consumable Costs
- Ease of Use – Consumables
- Ease of Use – Tooling System
- Ease of Use – Variables Control
- Repeatability of process to stop at the center of the PTH
- Labor Needs
- Technical Support (PCB industry specific)
- Calibrations
- The equipment must tolerate adjustments on four major variables: pressure, coolant flow, RPM of the grinding wheel, and time.

5.1.1 Controls

5.1.1.1 Pressure A person has to weigh the benefits versus the drawbacks for using a particular pressure setting.

- High Pressure (0.246 + kg/cm² 3.5+ psi)

Benefits:

- Fast grind times
- Low consumable usage

Drawbacks:

- Scratch depth is usually deeper
- The sample has greater sample deformation
- The next grind and polish times are increased (the longer grind times equate to an increase in labor and consumables, and loss in cycle time).

Note: The polish sequence is very sensitive to the scratch characteristics on the sample. The ability of the grind process to produce consistent scratch pattern and depth is dependent on the hardness of the material and the amount of pressure.

- Low Pressure (0.035 – 0.246 kg/cm² 0.5–3.5 psi)

Benefits:

- Less scratch depth and sample deformation
- The scratch characteristics on the sample are more consistent (regardless of the hardness of the material)

Drawbacks:

- Higher consumable usage
- Longer grind times

5.1.1.2 Volume of Water/Coolant The water serves two purposes: (1) to prevent heat generation due to friction in the samples, and (2) to retard the abrasive paper from filling with grinding debris causing it to lose its ability to cut material efficiently. Use a generous amount of water/coolant.

Note: Filter the incoming water. This prevents rust, calcium deposits, and debris carried in the water from contaminating the grind process. Calcium deposits sprayed on the grind wheel during the fine grind sequence will cause deep scratches to be formed that the fine grit abrasive paper is unable to remove.

5.1.1.3 Abrasive Paper RPM The rotation speed of the abrasive paper controls the material removal rate and the amount of heat generation. Start at 300 RPM and tailor the process to the material being ground.

5.1.2 Calibrations

5.1.2.1 Grind Pressure The pressure gage measures the direct force required for the mount holder to touch the abrasive paper. To determine the pressure on each mount divide the pressure setting by the surface area of the mount being processed. The recommended pressure setting is approximately 0.35 kg/cm² (5 psi).

For Example:

(6) 3.8 cm [1.5 in] diameter mounts

Grind Pressure is 20.5 kg [45 lbs-force]

Area of Mount = 22.58 cm² [3.5 square in]
[2*pi*(radius)squared]

Area of (6) Mounts = 21.2 square inches

Grind Pressure (psi) = 45 lbs-force/21.2 square inches
= 2.12 psi

If the grinding wheel is reworked or a new one is installed, the pressure must be audited and adjusted accordingly.

This audit is not required when abrasive paper is used to rework the grinding wheel surface.

5.1.2.2 Motor Shaft Angle (See Figure 6) The motor shaft turns the mount holder which affects the flatness on the mounts. The motor shaft must be perpendicular (90 degrees) to the grinding wheel surface. The tolerance for the 90 degrees requirement is determined by knowing the distance from the grinding wheel to the mounting bolts on the motor shaft. The longer the distance the tighter the tolerance. This relationship should be checked on a regular (6-12 months) basis.

5.1.2.3 Location of Mount Holder on the Grinding Wheel (See Figure 7) The abrasive paper removes more material towards the outside edge of the grinding wheel. The mount holder should be positioned near the outside edge to take advantage of the removal rates. This is one method to maximize material removal without high pressure or large grit abrasive paper.

Note: If positioning the mount holder requires moving the motor shaft, ensure the motor shaft remains perpendicular to the grinding wheel.

5.1.3 Maintenance

5.1.3.1 Surface Damage on Grinding Wheel The abrasive paper is held in place by a metal disc. The disc surface is easily damaged when the tool stops rip the abrasive paper. The damage must be removed from the surface because it will cause the abrasive paper to rip and/or cause unwanted scratches on the mount.

Minor damage can be removed by abrasive paper. All other damage must be removed by a lapping process in a machine shop. When lapping the surface, take care the dimension between the edge the abrasive paper ring sits on the lapped surface does not change significantly. If this occurs, the abrasive paper holding ring will not work and allow the abrasive paper to rip.

5.1.3.2 Grinding Wheel Base Is Free of Corrosion/Debris Buildup Corrosion or trash buildup can cause the grinding wheel to be tilted which will affect the motor shaft perpendicularity.

The grinding wheel is rotated by a drive plate. This design allows a person to quickly swap out discs. The drive plate has a tendency to trap material and corrode. If a buildup occurs on the drive plate, the grinding wheel will not lay flat.

5.2 Tooling

5.2.1 Mount Holder Construction The mount holder is a platform that acts as reference zero between the tool stops and the reference edge of the mounts (See Figure 8). The tool stops are extended a predetermined dimension from the mount holder to ensure the microsection process.

at the centerline of the target PTHs. The dimension for the tool stops is a sum of the distance from the centerline of the target PTH to the centerline of the tooling holes plus the radius of the tooling pin.

5.2.1.1 Samples Are Held Tight The orientation of the samples in the mount holder will dictate how efficient material is removed during grinding. If the mounts in the holder are loose, the orientation will quickly be lost as they turn to the path of least resistance. This turning will reduce the abrasive paper's efficiency to remove material quickly.

There are various methods of securing mounts in the holder. Some of the common methods are: tooling edges on a mount or pins embedded in the mount. The method of holding the mounts is to each one's liking as long as orientation is maintained.

5.2.1.2 Deflection of Mount Holder (See Figure 9) The mount holder attaches to the motor shaft via a collar. A ball mechanism in the mount holder to deflect slightly when the mounts first come into contact with the surface. If the following problems are experienced, the mount holder must be repaired or replaced.

Too Tight The ball mechanism is too stiff and doesn't deflect. This is apparent because the abrasive paper quickly rips regardless of pressure settings and hardness of material. This can be tested by attempting to grind mounting material with no samples in it. This suggestion assumes there is no problem with the tool stops or grinding wheel surface.

Too Loose The ball mechanism can wear out where the deflection is too much. This problem is not as obvious. Too much deflection is indicated by mounts that won't grind flat or a circular scratch pattern ('crescent moon' in shape) on the outer edge of the mount. (Figure 23)

5.2.1.3 Weight of the Mount Holder Don't use mount holder with material of construction (i.e., aluminum and stainless steel) in the same process. The process settings will vary based on the weight of the holder. The best results have been experienced with a light material.

5.2.1.4 Base of Mount Holder Is Flat (See Figure 10) Over time the mounts wear a depression in the surface of the mount holder. As this depression becomes more significant, the grind process will start to undergrind. The surface should be checked for depressions several times a year.

5.2.2 Mount Holder Process Guidelines

5.2.2.1 Orientation of Mounts in Mount Holder (See Figure 11) As discussed earlier, the material removal rate is greater near the outer edge of the grinding wheel. Mounts should be oriented in the holder to take advantage of this.

The portion of the mount with the highest sample surface area should be oriented to the outer edge.

Note: The location in the mount holder (Figure 11) does not need to be the same for grind and polish sequences.

This will permit repeatable grind and polish results from run to run permitting a process to be developed and maintained. Being random in the orientation of the mounts make troubleshooting of the process nearly impossible. The key to success is consistency so one can predict how the process will perform.

5.2.2.2 Load All Holder Positions with Common Material

The mount holder develops flatness in all the mounts. This process is complicated when mounts with soft (kapton, adhesive) and hard material (epoxy, glass) are loaded in the same mount holder. Softer material reaches the tooling stops sooner than harder material. This creates scratch removal problems by the surface not being flat (i.e., crescent-moon scratches). (Figure 23)

5.2.2.3 Use Lower Pressure for Uneven Surfaces Some labs mount samples with a portion of the sample sticking out of the mount material. Whenever this condition exists, start with a lower pressure for approximately 20 seconds to prevent the uneven surface from ripping the abrasive paper.

5.2.2.4 Balanced Mount Holder The mount holder must be balanced from side to side (Figure 11) to ensure the mount grinds flat (i.e., prevent crescent-moon scratches). If there are not enough production mounts to balance the holder, make some 'dummy' mounts and insert them in the holder. The overall height of the 'dummy' mount must be approximately the same as the production mounts. Height is measured from the mount reference edge to the sample or hardmount surface (whichever is longer).

5.2.2.5 Debris Between Mount and Holder A hidden source of scratches is debris getting between the grinding wheel and the abrasive paper. A good habit to develop is to clean the grinding wheel whenever the abrasive paper is replaced.

5.3 Tool Stops In the past, technicians learned the skill for how far to grind (distance) with each grit of abrasive paper. This skill was developed through OJT and experience. The high volume microsection system controls this variable numerically using tool stops on the mount holder.

The tool stops work with mount holder to develop flat mounts and to define the end point for each grind sequence. To attain a scratch free surface the tool stops are set a specific distance (and tolerance) from the bottom of the mount holder (Figure 12). The user is thus able to set the removal distance for each grit size of abrasive paper to assure the scratches from the previous grit size are removed.

type of scratch management requires a thorough knowledge of the abrasive papers being used.

5.3.1 Calibration Proper setting of the tool stops involves an understanding of abrasive paper grit sizes, scratch depth, and deformation created by the grind process. The abrasive paper vendor can supply abrasive paper grit information. The tooling stops need to be set so the fine grind step has ample room to remove the rough grind scratch deformation.

Example: Managing Scratches Via Tool stops

Target Hole Distance
from Mount Tooling Edge
to Target PTHs = 0.584 cm [0.230 in]

Abrasive Paper Data

Grit Size	Scratch Depth
180	0.018 cm [0.007 in]
1000	0.0018 cm [0.0007 in]

Calculate Tool Stop Height for 1000 grit sandpaper

Target Hole

Distance -2* (sandpaper scratch depth)
0.584 cm -2* (0.0018 cm) 0.5804 cm [0.228 in]

****The sandpaper scratch depth is doubled to provide process tolerance for the removal of the 1000 grit abrasive paper scratches. The extra tolerance permits the removal of any sample deformation caused by 1000 grit scratches.**

Calculate the Tool Stop Height for 180 grit sandpaper

1000 grit sandpaper
Tool Stop Height -2* (sandpaper scratch depth)
0.5804 cm -2* (0.018 cm) = 0.544 cm [0.214 in]

5.3.2 Maintenance (See Figure 12) Stops need regular care and adjustment. If the tool stop height is set wrong, the grind process will miss the centerline of the target PTH.

Maintenance required are adjusting the tool stop height, testing for flatness of the stop, noting wear trends, and checking condition of tool stop's material.

Tool stop wear varies due to the exposure time and grit size of the abrasive paper. The need for accuracy is explained in the prior section.

The flatness of the tool stops should be monitored. The variation on the stops can alert the user to deflection problems in the mount holder collar, problems in the perpendicularity in the motor shaft to the grinding wheel, and corrosion buildup on the base of the grinding wheel. The recommended variation on the tool stop is 0.013 cm [0.005 in] from side to side. Any larger variation allows minimal point contact of the tool stop on the grinding wheel. Consequently, the stop wears out of tolerance faster.

Inspect the surface of the tool stops for cracks or other degradation. The tolerance level for defects is determined by the user's discretion.

5.3.3 Purchasing The primary characteristic considered when purchasing tool stops is the *Hardness of Material*. The hardness affects the wear characteristics of the stops. This should be monitored in case the vendor switches material.

5.3.4 Location of Stops On Mount Holder (See Figure 13) The tool stops must be positioned so the inside edge of the tool stop is on the arc from the outside edge of the mount. This location is critical to ensure flat mounts. If the tool stops are further in, the first rough grind will damage the outside of 2-3 samples (of 6) in the holder. The damage is in the form of deep scratches that cannot be removed and 'crescent moon' effect (Figure 23). These problems will become evident early in the polish process.

5.3.5 Tool Stop Audits

5.3.5.1 Stops Are Touching Some common methods for auditing when the tool stops touch the abrasive paper are:

- Grease Pencil – Mark the surface of all the stops. As the stops touch, the abrasive paper will remove the grease on the surface. When all stops are clean, the grind step is complete and the desired flatness is developed.
- Flat Surface – Lay the mount holder on a flat surface and see that all the tool stops are touching. A disadvantage with this method is the mounts may be scratched when doing the check. The flat surface must be clean.
- If the rough grind step is stopped prematurely, a long period of fine grind will result. If the rough grind is stopped too late, the fine grind will not remove the rough grind and stop at the centerline of the target PTHs.

5.3.5.2 Stops Touch Too Long (See Figure 14) The abrasive paper will preferentially grind the inside edge of the mounts when the process is allowed to run while all the tooling stops are touching. This will cause the mount to not be flat and cause the same problem as crescent-moon scratches (Figure 23). This can be avoided by doing frequent audits of the tool stops touching the abrasive paper.

5.4 Consumables Consumables must be of uniform quality. The process will be set assuming the abrasive paper's grit size, life span, and resistance to water. If any of these qualities vary, the consistency of the overall process is in jeopardy.

5.4.1 Abrasive Paper The user should be familiar with characteristics of the abrasive paper used. The key characteristics are the grit size and life of the abrasive paper.