Published by Buehler, a division of Illinois Tool Works
Volume 2, Issue 2

SUM NOTES

Semi-Automated Parallel Material Removal

Introduction

Failure analysis and production control are key steps in any successful product development. However, revealing the area of interest for microscopic investigation in a multilayer integrated circuit, stacked package or interconnections between solder balls (BGA) in packaged components requires a great deal more precision than typical metallographic preparations.

The material removal has to be controlled. It is necessary to gently remove each layer of material and to be able to stop the process precisely at the failure or feature of interest. If a defect is removed from the sample due to excessive grinding, it may persist in production and lead to large losses of money.

Parallel material removal or parallel lapping is usually done manually, enabling the operator to continuously examine the surface. Each time the operator must confirm the layer of interest is not yet exposed and that the surface is still parallel. This takes time and an operator with great skill.

Automating parallel material removal provides the operator with control. The risk of passing the area of interest is reduced and time saved. This Sum-Note will focus on automated parallel material removal with Buehler's MPC™ 3000 Micro-Precise Backside Grinding System. It is designed for both front-side and back side material removal on bare chips or packaged components. The versatility of this system enables a variety of electronics applications to be tackled.

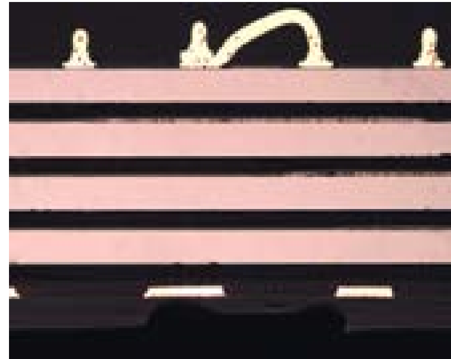
Preparation Procedure

Sectioning

The first step is to section the specimen to a suitable working size. For electronic materials, two common methods of sectioning are cleaving and precision sectioning.

Cleaving is a simple and effective way of removing a die from the parent wafer for cross sectional analysis. The tools required are a sharp carbide or diamond scribing tool and a means of initiating the break. The distance of the plane of cleaving, from the plane to be examined, must take the sample preparation procedure into consideration. For example, if the die is to be prepared using only fine abrasive techniques; the plane of cleaving should be as near to the plane of interest as possible.

A precision saw, such as the IsoMet® 5000, will produce cuts at a precise location with minimum deformation. This is accomplished with relatively thin blades, which have diamond or cubic boron nitride abrasive bonded to the periphery of the blade. The cutting process is controlled by a combination of the blade speed and feed rate. Typically low concentration diamond blades, Buehler IsoMet® 10LC or 5LC wafering blades, are recommended for electronic materials.



Cross-section of a 4GB SD Drive, approximately at 100x. Taking measurements of a cross-sectioned package can determine the exact location to backside grind.

For sectioning thin materials, the Precision Table accessory (11-2694-160) is ideal. It will readily accommodate wafers up to 4in. (100mm). When using this accessory, you must first mount the wafer to a support as indicated below.

- Using a hot plate, preheat the mounting plate to158°F (70°C).
- While holding the plate securely, spread Buehler Lakeside 70 mounting cement (40-8100) evenly over the area where you want to place your specimen.
- Place your specimen and press it firmly.
- Let the assembly cool.

Mounting

The Sample Mounting Unit supplied with the MPC™ 3000 adjusts for any differences in parallelism between the outer surface and layer of interest. For example, the exposed surface of the silicon device is not always parallel with the opposite surface of the package, meaning the silicon provides only a reference surface.

1. Clean all surfaces with a lint-free cloth and alcohol each time the system is used.
2. Power up the system. Place a Sample Mounting Plate on the Heating/Cooling Plate. Align notches and pins to ensure the end result is a flat, parallel mounted specimen.
3. Activate the mounting vacuum. Place a sample, silicon side down, against the vacuum opening. Adjust the sample until silicon completely covers the vacuum and a good seal is

achieved.

4. Place approximately 0.5 grams of mounting wax (40-8100) on the center of the Sample Mounting Plate.
5. Activate the heating and cooling cycle. The Heating/ Cooling Plate reaches a maximum temperature of approximately 230° F (110° C). It will maintain this temperature for approximately two minutes.
6. Place the Upper Vacuum Block (with sample adhering by vacuum) over the Heating/Cooling Plate. When Heat/Cool light flash, place sample on the sample holder.
7. The package side of the sample will contact the melting wax. If too much wax has been used, apply additional pressure to the Upper Vacuum Block. Check that pins rest on the Heating/ Cooling Plate.
8. Allow the sample to cool. Lift the Upper Vacuum Block and remove the sample. The exposed surface of the silicon integrated circuit will now be parallel to the back of the Sample Mounting Plate.

Controlled material removal

Using special consumables, it is possible to remove material (layers) with a precision of 0.4µm. Surface areas of 20x20mm or less can be processed with minimum edge rounding. In addition, LSI (Large Scale Integration) packages can be backside lapped to expose the interconnects.

General Procedure

1. Attach an abrasive disc to the platen. UltraPrep™ Type A, PSA backed Diamond Lapping Films are highly recommended.
2. Place the sample on the bottom surface of the Sample Sled. Start vacuum pump to firmly attach the sample.
3. Adjust digital micrometer and slide the Sample Sled toward it. Check that the sample is retracted into the fixture.
4. Place the Grinding Fixture (diamond feet down) on a hard, flat surface (i.e. a calibrated granite surface plate). Check that the sample is not touching the surface plate.
5. Zero the setup in order to track the material removal. Hold Grinding Fixture firmly against the flat plate. The sample should be contacting the flat plate. Turn the Digital Micrometer until the shaft contacts the Sample Sled. Press the ZERO button on the Digital Micrometer.
6. Set the desired material removal amount and lock the micrometer.
7. Place the Grinding Fixture on the platen and attach the Oscillating Arm.
8. Apply additional weights (60-3045) to increase grinding rate as needed. Weights can be added by threading the weight rod to any of three threaded holes on the top plate of the Grinding Fixture.
9. Select a grinding speed from 10 to 500 rpm.
10. Direct the water hose to the platen. Water must always be on when the wheel is in motion.
11. Select the Oscillating Motor speed which activates the Oscillating Motor and the platen.
12. Turn off grinding wheel once the selected amount of material has been removed. When silicon is no longer deposited on the DLF, turn off the oscillating motor and the water.

To continue grinding, apply the appropriate consumables (see Table 1) to the platen surface and repeat the steps 6-12. Change the angle of the sample surface 90 degrees after every grinding or polishing operation. After reaching the target, select the polishing pad and suspension based on the materials in the sample. Some examples are listed In Table 2. Polish at 100 – 150 RPM until the desired result is achieved.

Table 1. Grinding Consumables & Guidelines

Distance from Target (m)	Diamond Lapping Film (m)	Platen Speed (RPM)
300	30/15	150-200
150-300	15/9	150-200
50-150	6/3	150-200
10-50	3/1	150-200
<10	0.1	100-150

Table 2. Polishing Consumables & Guidelines

Metal	Cloth	Polishing Media
Silicon Die or Gold	MasterTex® or ChemoMet® (best for flatness)	MasterPrep® Alumina Suspension
Aluminum wire pattern	TexMet® 1500	MasterMet® Colloidal Silica Suspension
Copper wirre pattern	ChemoMet®	MasterPrep® Alumina Suspension
Aluminum with Tungsten	ChemoMet®	MetaDi® Diamond Suspension 0.1 micron
Gold with Tungsten	ChemoMet®	MasterPrep® Alumina Suspension

Equipment*
MPC 3000 Intergrated Parallel Material Removal System
IsoMet® 5000 Linear Precision Saw

Consumables*
Diamond Wafering Blades 5LC, 10LC
Lakeside 70 Mounting Cement
UltraPrep™ Type A, PSA backed Diamond Lapping Films
MasterTex®
MasterMet® Colloidal Silica Suspension

**For a complete listing of Buehler Equipment and Consumables, please refer to Buehler's Equipment Buyer's Guide and Buehler's Consumables Buyer's Guide*

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