1120 Via Callejon ■ San Clemente ■ California ■ 92673 ■ USA
Telephone: (949) 492-2600 ■ Fax: (949) 492-1499
e-mail: info@southbaytech.com
www.southbaytech.com

Composite Plate Conditioning for Flatness

Introduction

The copper (Cu) composite plate is unique in it's ability to precisely lap and polish fragile semiconductor crystals to critical flatness and surface roughness requirements. Conversely, traditional cast iron (Fe) plate processes are too aggressive, causing fracturing and chipping to the crystals. However, Cu plates have a tendency to wear relatively quickly during processing and will eventually become out of flatness. As a result, measuring plate flatness and conditioning of the Cu plate must be done with regularity and diligence.

Lapping Plate Characteristics

The Cu composite lapping plate is made with a unique blend of powdered metal combined in a resin matrix. This unique combination of materials offers several technological advantages over cast Fe lapping plates, which include:

- Reduced mechanical damage to brittle crystalline materials, such as II-VI semiconductors (CdZnTe)
- Superior surface finishing capabilities, allowing for multiple process steps to be performed on the plate
- Greater uniformity of abrasive charge onto the lapping plate,
- Ability to provide a semi- polished surface directly from the lapping process

Listed below are some unique material properties of the composite material versus a traditional cast iron plate:

	Compostion	Hardness	Thermal Stability	Dimensional Stability	Wear
	Iron	Very hard	High: material is thermally conductive	High	. Wears in specimen contact area. Other area wear is minimal.
	Powder Cu & Resin	Medium	Low-Medium: excessive heat can cause material to breakdown	Low-Medium: slowly creeps over time	Wears in specimen contact area and plate tends to exhibit convex shaping after extended lapping time

Plate Conditioning: Principles and Practice

During processing, constant removal of both specimen material and plate material occur simultaneously, resulting in a change in plate flatness over time. Specimen quality is a direct result of plate condition, and therefore proper plate conditioning is crucial in preparing high quality specimens. Plate conditioning is the process by which the lapping plate surface is machined away in a controlled manner to re-create the original plate flatness. A diamond plated conditioning ring is used to remove material from the lapping plate, resulting in a change to the surface flatness of the plate. This basic arrangement is shown in Figure 1.

Figure 1: Image showing the Model 92002 Workstation with a diamond-conditioning ring. The ring is used for removing material from the lapping plate surface to create a flat surface for lapping processes.

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Conditioning of the lapping plate is affected by three primary parameters:

a) Position of the conditioning ring
b) Weight of the conditioning ring
c) Polishing machine parameters

A) The position of the conditioning ring has a drastic affect on the shape of the lapping plate. Generally, there are three primary positions that are used for plate conditioning and are shown in the diagram below.

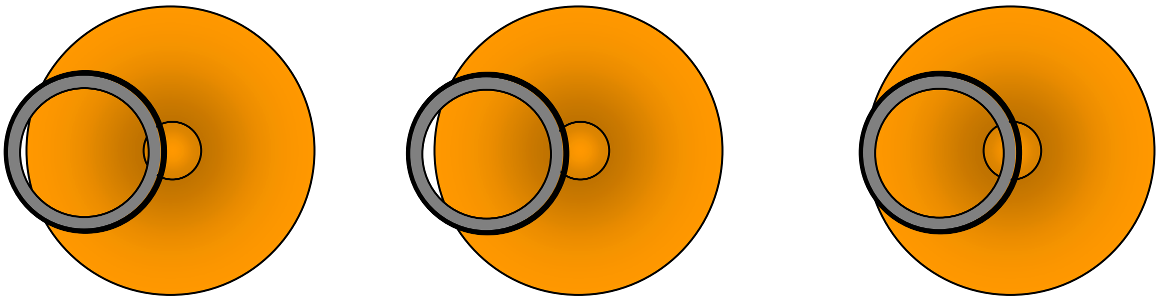

Figure 2: Schematic illustration of the conditioning ring positions during plate conditioning.

Position A: The diamond conditioning ring centered over the plate with even amount of overlap from the outside edge and inside edge of the lapping plate. This is the general starting position when beginning a conditioning process. This is the optimum position for reducing waviness or low-in-the-middle plate shapes. Conditioning in this position for too lengthy of a time will cause the plate shape to become convex.

Position B: The ring is predominately overlapped to the outside edge of the lapping plate. This will cause more plate material to be removed from the outer diameter areas of the plate circumference.

Position C: The ring is overlapped to the inside edge of the lapping plate. During the conditioning process more material will be removed from the interior areas of the plate.

B) If the lapping plate is severely out of flatness (hundreds of microns), additional weight should be added to the conditioning ring. Adding weight to the conditioning ring inceases loading force and will increase the material removal rate of the plate, reducing the conditioning time. **Use caution as the increase in removal rate will cause rapid changes in plate shape.**

C) Polishing machine parameters will also affect the conditioning process. In most cases, the workstation speed should approximately match the wheel speed. The advantage of using matching speed and complementary direction is a highly uniform removal across the plate surface by the diamond-conditioning ring.

Monitoring & Measuring Plate Flatness

The Model 92031 Flatness Gauge Kit is designed to help the user maintain plate flatness by periodically taking measurements of the plate shape following processing. The gauge utilizes digital micrometer that is initially zeroed on a granite leveling plate. The gauge is then placed onto the lapping plate and a measurement taken. This provides a direct measurement of how much the plate has deviated from the zero position. Measuring various points along the lapping plate surface provides a picture of the overall shape of the lapping plate.

Figure 3: Model 92031 Flatness Gauge Kit showing the flatness gauge and granite leveling plate.

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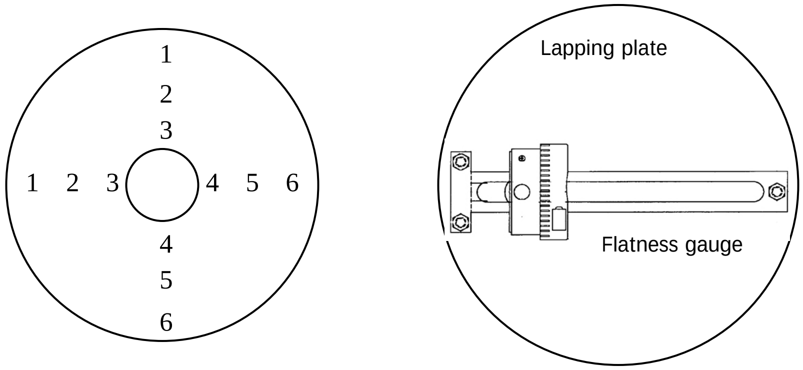
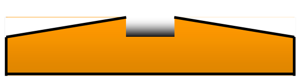
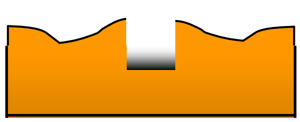
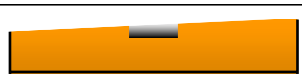
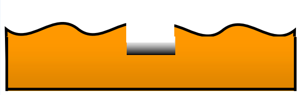


Figure 4: Schematic illustration of the locations used for measuring plate flatness (far left) and the orientation of the flatness gauge on the lapping plate during measurements.

Determining Plate Flatness (Shapes)

During sample processing, **the Cu lapping plate has a tendency to exhibit a convex shape after use**. For that reason the Cu plate is typically conditioned to have a slightly concave shape prior to sample processing. Using the flatness gauge for measuring various points on the lapping plate and relating these to the plate shape, proper conditioning can be completed in a short amount of time.
Below are common plate shapes that would be seen from measurement data taken from the plate surface.

PLATE SHAPE	DESCRIPTION		SAMPLE DATA SET (MICRONS)	
 FLAT	This shape is met to tolerances +/- 2.54 µm. It is not the prefered starting shape for composite plates. Slightly concave from the flat surface is ideal for starting.		1. 1 2. 2 3. - 1	4. 2 5. -1 6. 1
 CONCAVE	This shape occurs when material is removed faster from the inside diameter of the plate than outside.		1. 6 2. 3 3. 2	4. 2 5. 3 6. 6
 CONVEX	This shape occurs when material is removed faster on the outside diameter of the plate.		1. 2 2. 7 3. 10	4. 11 5. 6 6. 2
 LOW in the MIDDLE	This is a typical shape incurred after a specimen has been lapping for a significant amount of time.		1. 2 2. -7 3. 1	4. 2 5. -8 6. 2
 TILTED	This is a not a typical shape which occurs by itself. Usually it's seen in conjunction with one of the other shapes.		1. 0 2. 10 3. 17	4. 20 5. 25 6. 30
 WAVY	This is a case where the plate has a wave around the diameter of the plate.		1. 3 2. 0 3. 7	4. 15 5. 18 6. 21

NOTE: When measuring the plate flatness, remember that the plate tolerance for flatness is + / - 2.54 microns. Therefore, readings between -2 and +2 microns show the plate to be flat and within the desired specification.

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Basic Procedure

1. Using the Model 92031 Flatness Gauge Kit measure several points across the plate. A minimum of two lines of six points across the diameter of the plate is recommended. See Figure 4 for an illustration of the measurement technique.

2. Evaluate the measurement data collected and determine which plate shape(s) are most similar. **Refer to diagram shown on previous page for determination of plate shape.**

3. According to the plate shape observed, determine the positioning of the conditioning ring. Unless the plate is convex then usually it's best to start with the ring centered (as shown in Figure 2A). **It's important to note that on a perfectly flat composite plate if a conditioning ring is centered it will cause the plate to take on a convex shape.**

4. Wet the entire lapping plate with water. Then setup a slow water drip onto the lapping plate.

5. Set polishing machine parameters so complementary rotation direction of wheel and conditioning ring are achieved. Also, rotation speeds should be similar. If using the Model 920 the workstation rotation speed is at the maximum setting of 10 and the wheel speed is adjusted to match (usually between 1-2 dial setting).

6. Initially run the conditioning process for 5-15 minutes and then check flatness with measurement gauge. Then adjust conditioning time accordingly. Use the plate shape as a guide for plate conditioning, noting how quickly specific plate shapes change over time.

7. If the lapping plate exhibits a combination of several shapes its best to run the process with a centered conditioning ring and reducing the combination shaping until a convex shape is obtained. Once this has been achieved, then move the ring to the inside to flat the plates shape and create the desired shape. This process typically would take around 30 minutes.