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PM5 Lapping & Polishing Machine Standard Operating Procedure

QUICK GUIDE

PROCEDURE OVERVIEW for lapping & polishing

1. Sample Mounting on Glass Carrier
2. Placing the Sample on the Jig and Adjusting Downward Force
3. Filling the Abrasive Feed Cylinder
4. Lapping Procedure
5. Polishing Procedure
6. Baseline recipes for Si, InP, GaAs Lapping and "Mirror" Polishing

⚠ CRITICAL PRECAUTIONS AND COMMON MISTAKES

- 3 inch wafers or any sample smaller then 3 inch wafer can be used
- Inspect and clean both surfaces of the glass carrier before sample mounting
- Never intermix slurry solution (e.g. put 9 µm slurry grit in the 3 µm slurry cylinder)
- Never shake the abrasive feed cylinder, as this motion will clog the valve
- Do not overfill the abrasive feed cylinder; a full cylinder is actually only filled halfway to the top
- When you manipulate the lapping/polishing jig with the surface to polish facing down, be sure to hold the central ring with your fingers
- The lapping plate, mounting jig and the lapping/polishing jig are heavy, so be very careful when manipulating them
- Be careful when using hotplate, LED flashes when hotplate is not actively heating but the surface is still hot

Before you start

Check the lapping plate flatness

Tool condition for the next user

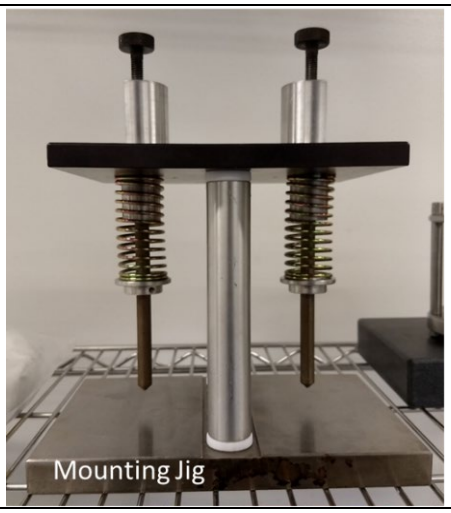
Clean the machine that will prevent next user work from being contaminated

1. Sample Mounting on Glass Carrier

1.1 Place mounting jig on a hotplate inside the hood

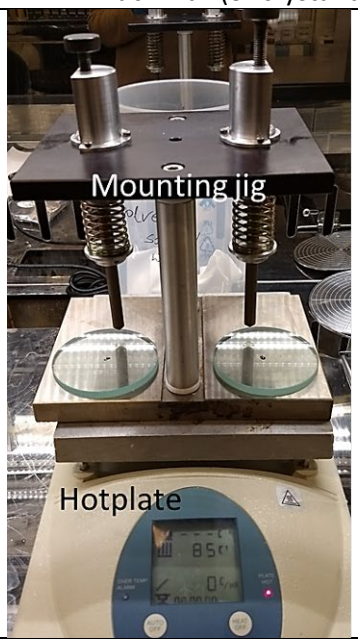
1.2 Inspect and clean both surfaces of the glass carrier

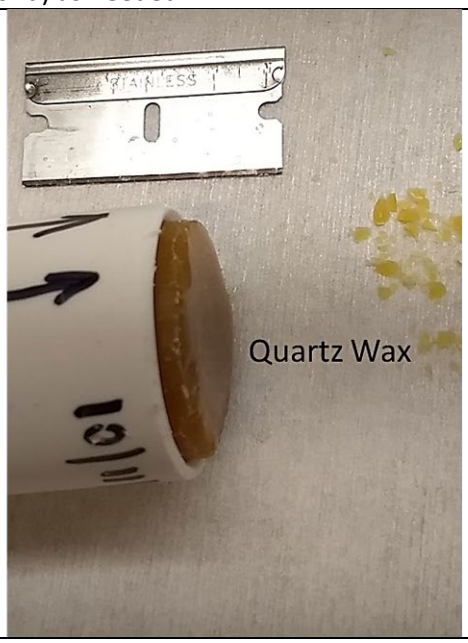
Note: The sample should be mounted on the worst looking side of the glass carrier, perfect side goes against the face of the vacuum chuck on the lapping jig

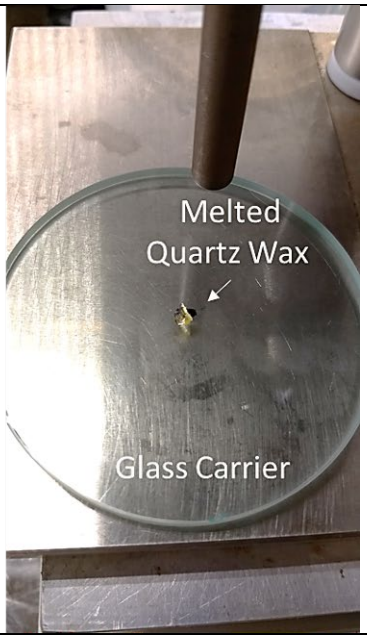


1.3 Place the glass carrier on the mounting jig and set the temperature

1.4 Apply some wax or crystal bond on the center of the glass carrier and let it melt; only use as much wax (or crystal bond) as needed







Notes:

- Use the Logitech quartz wax (ICON 200) for the Silicon, InP and GaAs wafers. The quartz wax is a lower temperature wax, soluble in isopropanol. Typically used at a temperature of 80 - 85 °C.
- Use crystal bond for SiC and Sapphire wafers; it is less viscous than wax, but has a higher shear strength. The Crystal bond (509 Amber, Flow Point: 121°C, Solvent: Acetone) is usually used were the process requires high plate speeds and pressure to achieve material removal. It can

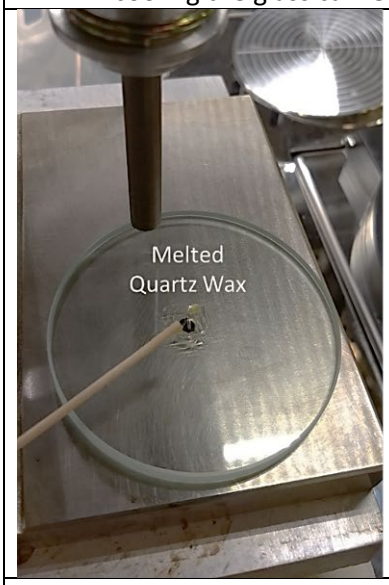
also be beneficial when mounting the small pieces of wafer where there is some risk of the pieces becoming detached from the support substrate.

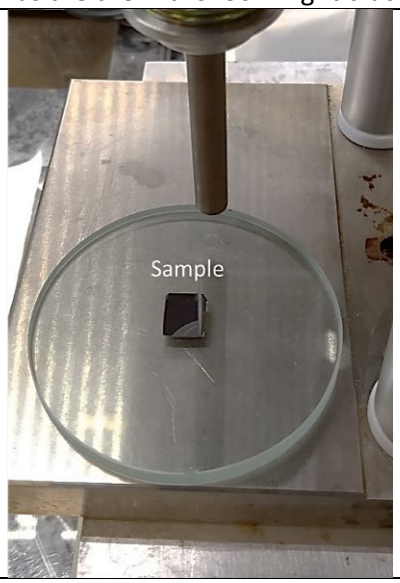
1.5 Measure sample thickness before mounting on e.g. Mitutoyo thickness measurement unit

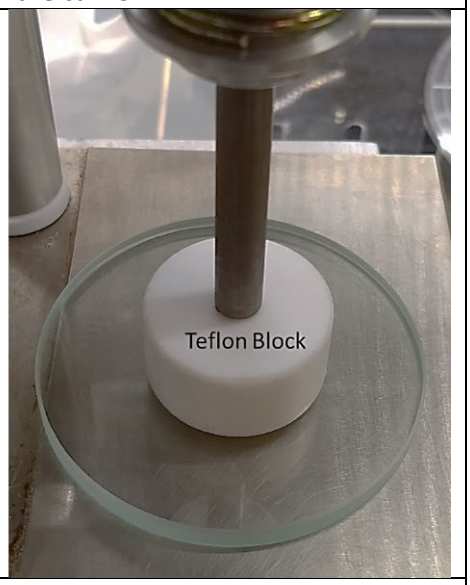
1.6 Mount the sample on the glass carrier by pressing down with Teflon block;

1.7 When mounting the sample, place Teflon block while holding the jig spring. Then, carefully release the spring. Be careful not to pinch/press your fingers.

1.8 Remove the jig from the hotplate for cooling down the temperature; do not use liquids to force cooling the glass carrier as the thermal shock might crack the carrier





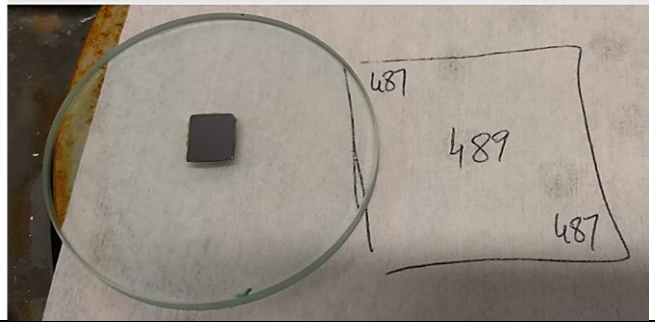


1.9 After the glass carrier is at room temperature, carefully remove excess wax with a razorblade; scrape parallel to the substrate edge so you won't accidentally pop the substrate off the carrier; blow off wax particles with a N_2 gun and clean off wax residue from the glass carrier

1.10 Turn the carrier over and look for air bubbles under the sample; if air bubbles are too many or cover too much area, place carrier on hotplate to repeat mounting procedure

1.11 Measure thickness of the sample mounted on glass carrier before lapping or polishing

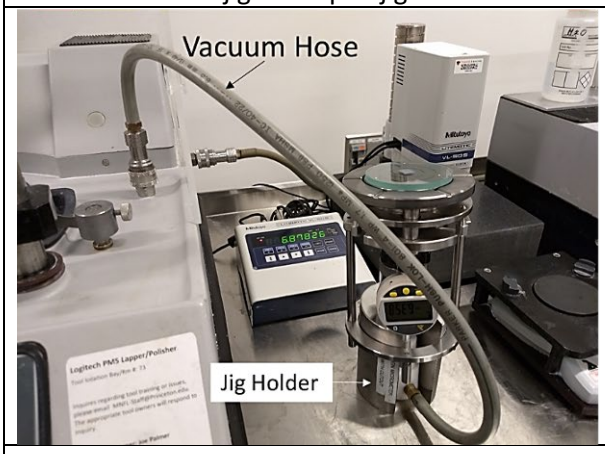
Sample mounted on glass carrier and its thickness (sample + wax) measured with Mitutoyo thickness measurement unit



2. Placing the Sample on the Lapping Jig and Adjusting Downward Force

2.1 Connect vacuum hose to the lapping/polishing jig

2.2 Hold the jig face up in jig holder and set the sample on it



2.3 Adjust the downward force by placing the jig on the sample-loading gauge and turning the load adjustment screw:

- Up adjustment: Reduces the downward force
- Down adjustment: Increases the downward force

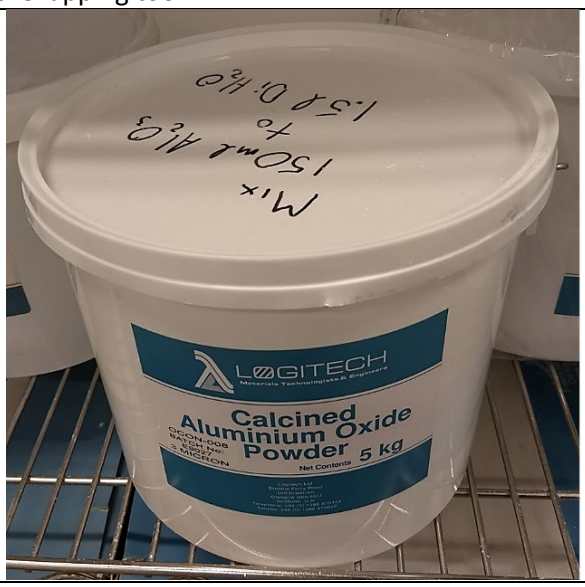
Notes: The lapping rate is dependent on the downward pressure and the size of the substrate; The more pressure, the faster the lapping rate (Pressure = force / area). If you are lapping a sample to a thickness below 200 µm, you may have to reduce the pressure to prevent your substrate from cracking.

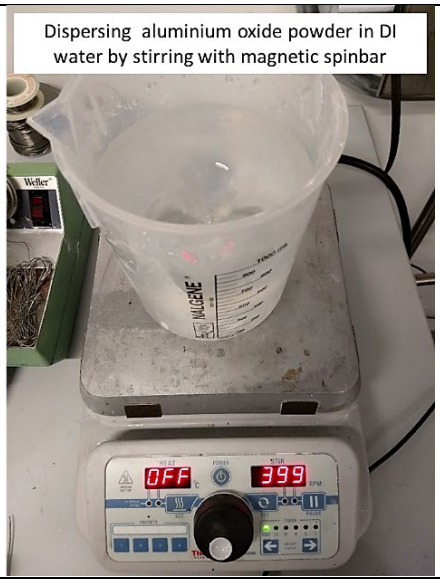
3. Filling the Abrasive Feed Cylinder

3.1 In a beaker prepare a slurry solution that is a 15% mix of 3 µm or 9 µm alumina oxide powder in DI water. In a fume hood add proper size of metal oxide powder into the water. **Remember that process of handling metal oxide powder must be done in the fume hood.**

Note: A full cylinder contains 1.5 liters of slurry; 150 ml of this is aluminium oxide and a slurry level should not be above the halfway line on the cylinder

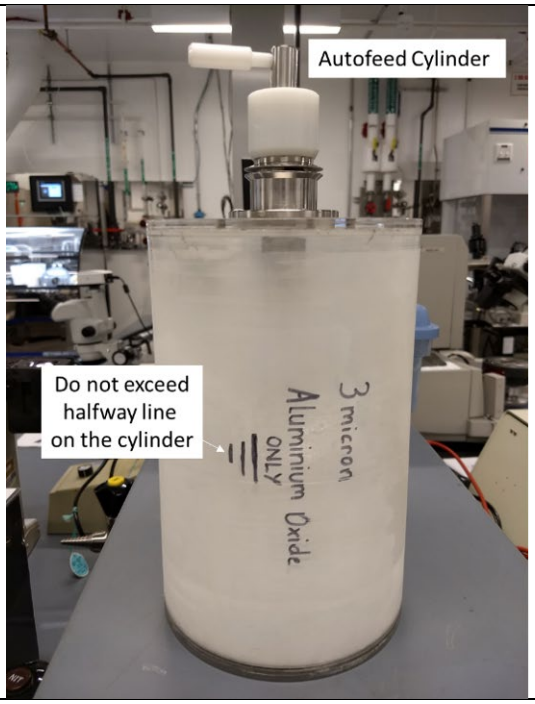
3.2 Disperse the powder well by stirring with magnetic spinbar on the stirring plate located next to the lapping tool.

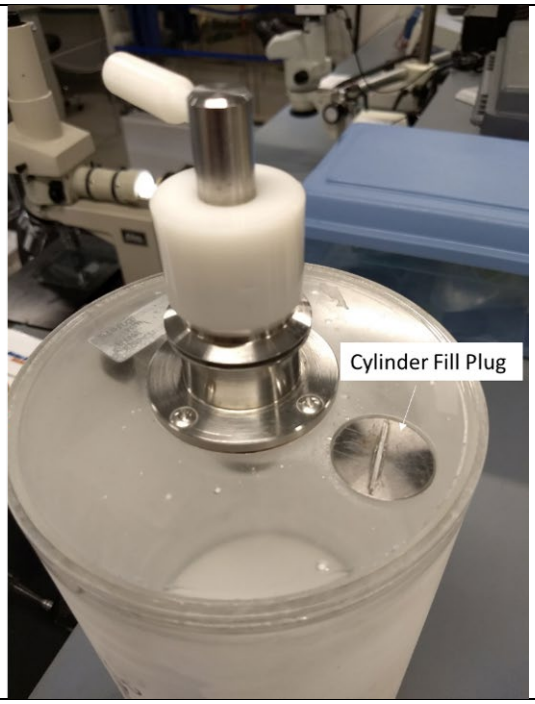




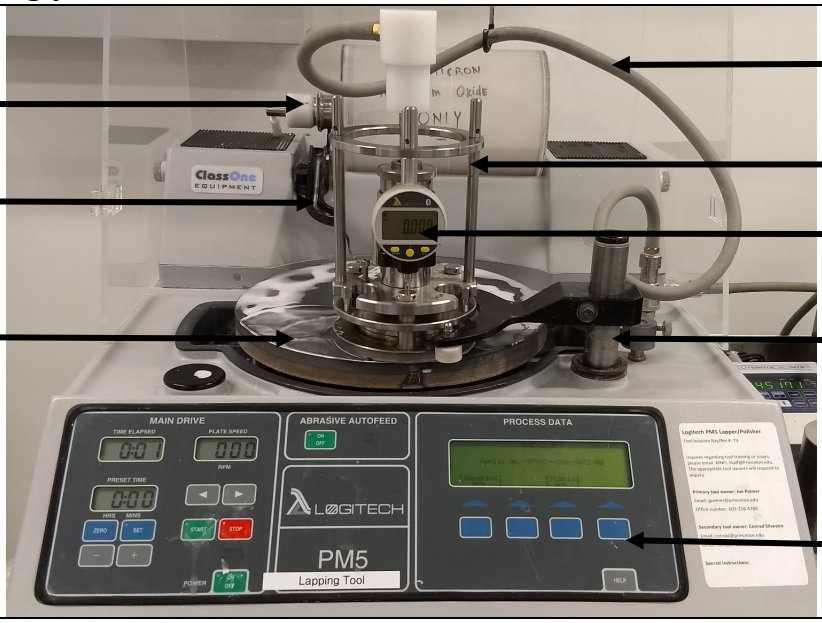
3.3 In the fume hood, carefully unscrew cylinder fill plug with flathead screwdriver and pour well dispersed slurry

3.4 Clean the threads of the fill plug and screw the fill plug back into position; slurry should not leak out





4. Lapping procedure

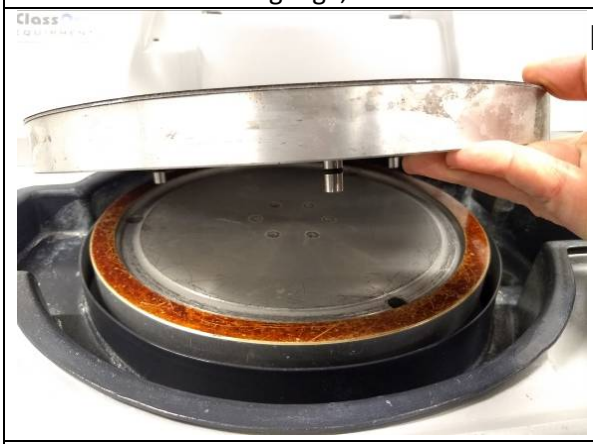


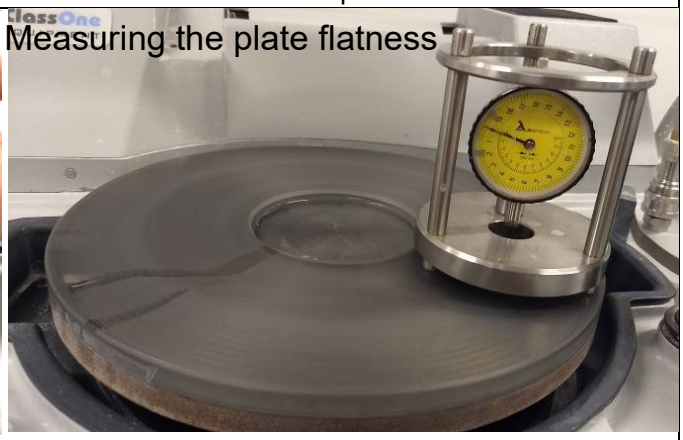
4.1 Place lapping plate centrally in groove of the driver plate by holding the lapping plate by its edge

4.2 Manually rotate the plate in this groove until the drive pins are located in the holes and allow the plate to drop gently into place; be careful not to pinch your fingers

4.3 Check the plate flatness

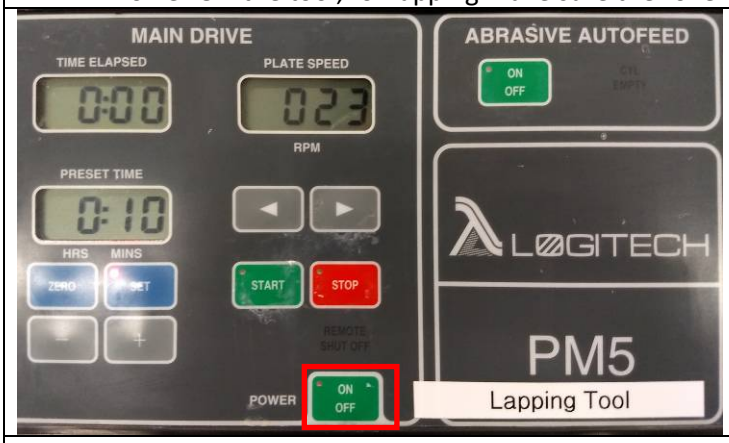
Note: If the pointer on the dial gauge is clockwise of the zero position the plate is convex; if the pointer is anti-clockwise of the zero position the plate is concave. If the plate is flat, i.e. within 1-2 microns as indicated on the dial gauge, there is no need to correct the curvature of the plate.

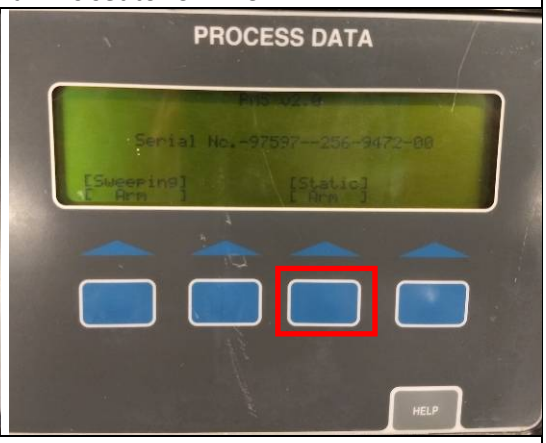




Measuring the plate flatness

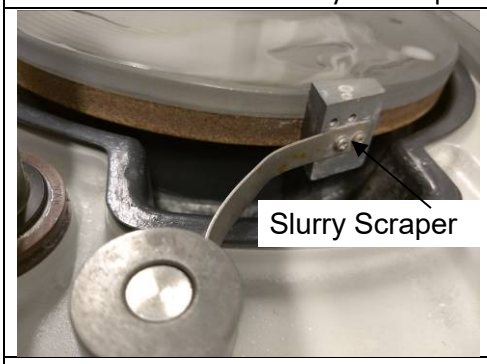
4.4 Power ON the tool; for lapping make sure the roller arm is set to "STATIC"

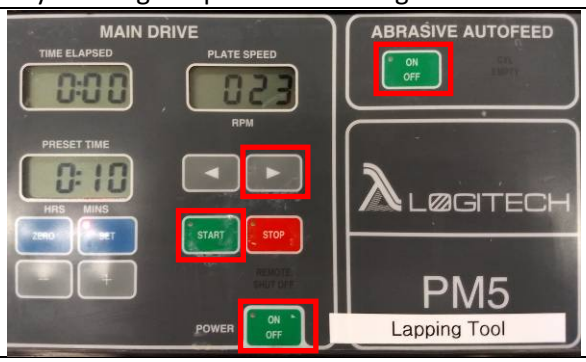




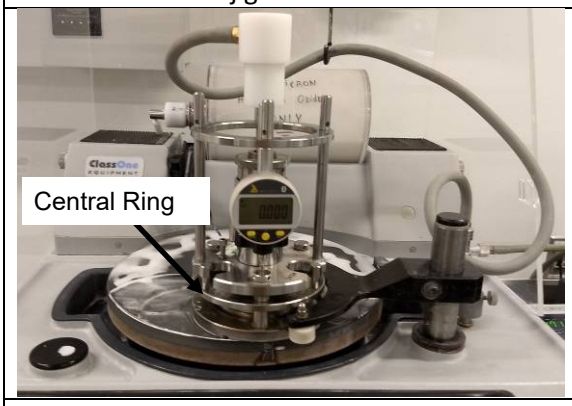
4.5 Set the slurry scraper so that the scraper is just touching the edge of the plate

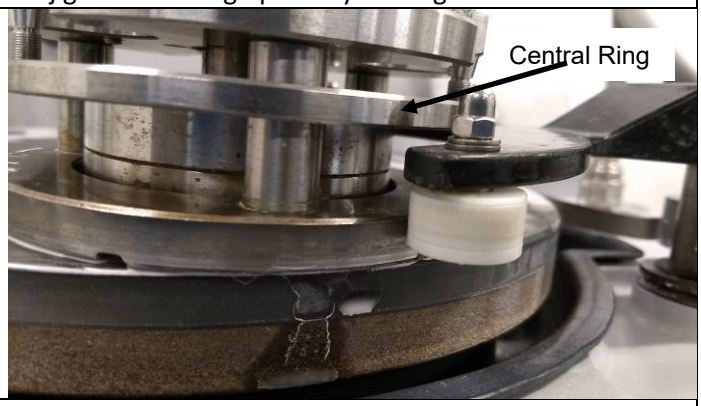
4.6 Deliver some slurry on the plate by rotating the plate and turning ON Abrasive Autofeed





4.7 Place the jig between rollers and hold the jig's central ring up with your fingers





4.8 Reset the timer and start rotating slowly

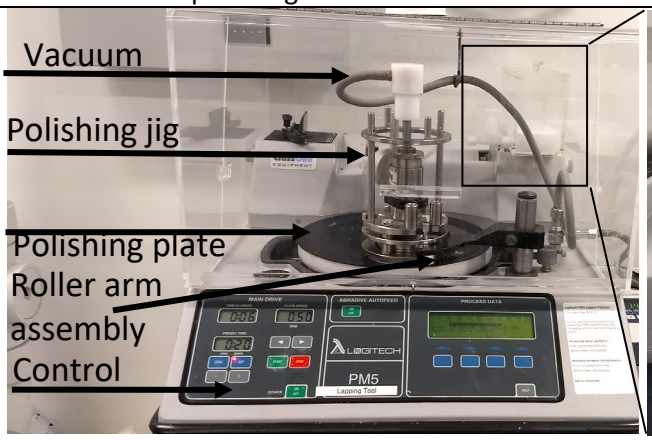
- Increase the rotation speed to desired speed
- Slurry rate should be 1-2 drops per second; do not adjust the valve while the cylinder is rotating

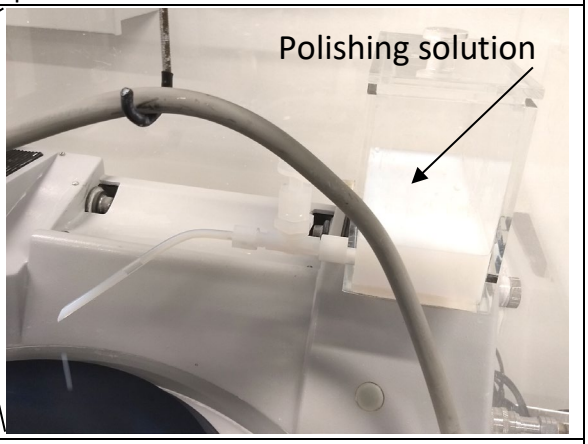
4.9 When the time is over, press the button to stop the alarm

5. Polishing procedure

5.1 Place polishing plate and set the slurry scraper

5.2 Position polishing solution container above the plate

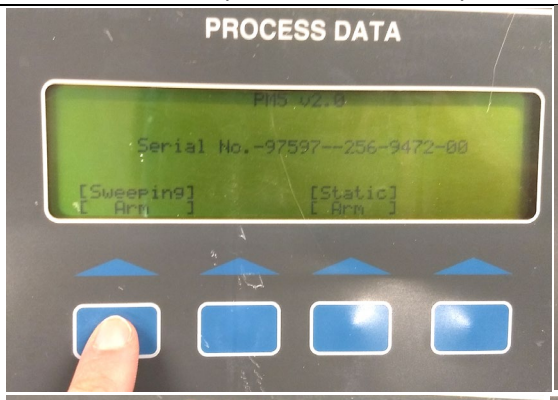


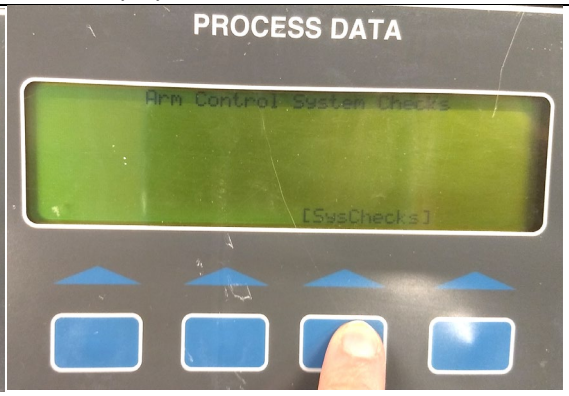


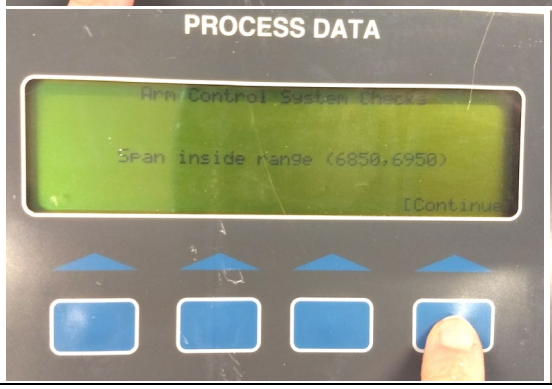
5.3 Power ON the tool and select "Sweeping arm"

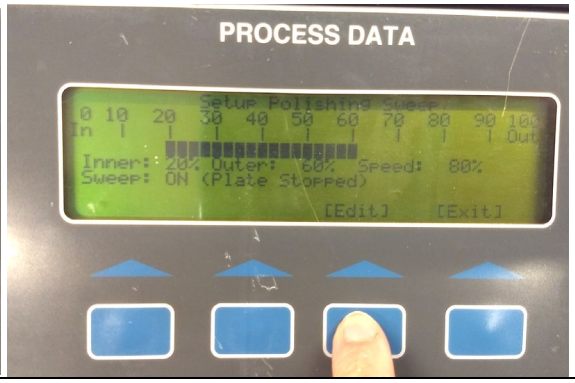
5.4 Select "SysChecks" and "Continue" to reach the Polishing Sweep Parameters screen

- Set Inner Sweep Limit, Outer Sweep Limit and Sweep Speed









5.5 Wet the polishing plate with the polishing solution

5.6 Place the jig in the roller arm

5.7 Reset the timer and start rotating slowly

- Make sure the arm is in sweeping mode
- Increase the rotation speed to desired speed

- Make sure polishing solution is 1-2 drops per second

5.8 When the time is over, press the button to stop the alarm

6. End of lapping and polishing

- Take up jig's central ring, turn upside down the jig and put it gently on the jig holder
- Disconnect the vacuum hose
- Take off the glass carrier with sample
- Wash thoroughly in the sink with DI water and blow dry with N2 gun
- Wipe dry with TexWipes
- Check the sample state with microscope, measure the thickness, etc... If needed, continue lapping or polishing of the sample.

When finished, remove the lapping plate and fixtures, and clean the machine, slurry chute and scraper thoroughly to avoid any contamination of the next process

7. Baseline recipes for Si, InP, GaAs lapping and "Mirror" polishing

This is only a guide and you will have to make your own tests

7.1 Silicon (Si) sample lapping and polishing conditions

Lapping

- Plate type: Non grooved cast iron (samples < 2'' in diameter)
- Lapping slurry: 3 µm Al_2O_3& Di H_2O (150 ml abrasive - 1.5 liters Di H_2O)
- Plate speed: 30 - 50rpm
- Jig load: 1000 - 1500 g

Notes:

If the wafer is above 2"diameter a radial grooved cast iron plate is used.

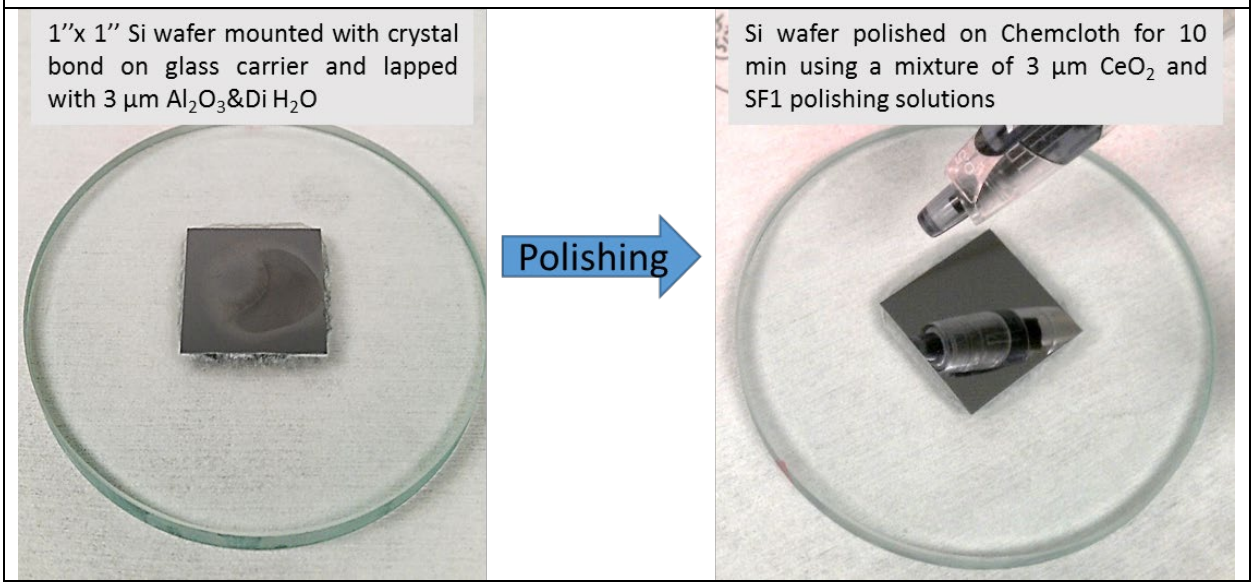
To speed up the material removal rate for large wafers you can use a 2 stage lapping process 9 or 12 µm Al_2O_3& Di H_2O followed by a 3 µm Al_2O_3 & Di H_2O lapping stage.

Polishing

- Polishing pad: Chemcloth
- Polishing slurry (Option 1): SF1 (32 nm particle size)
- Polishing slurry (Option 2): CS60 (60 nm particle size)
- 3 µm CeO_2 & Di H_2O (can be used in conjunction with the above slurries)
- Plate speed: 25 - 70 rpm
- Jig load: 1000 - 1500 g
- Sweep speed: 20 - 100%
- Sweep amplitude: 100%

Notes:

The 3 µm CeO_2 is mixed with Di H_2O in the fume hood (225 ml powder - 1.5 liter H_2O). Then, it is agitated in the cylinder. The normal polishing practice is to deliver 3 µm CeO_2 on to the polishing pad for 30 minutes with the SF1 (delivered from the separate feed unit). After 30 minutes the CeO_2 is removed and the polish is continued for a further 60 minutes.



7.2 Indium Phosphide (InP) sample lapping and polishing conditions

Lapping

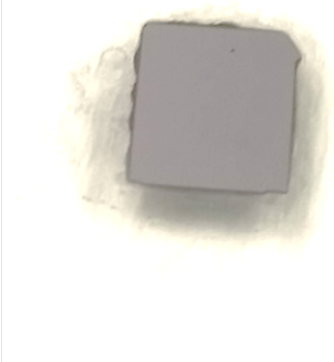
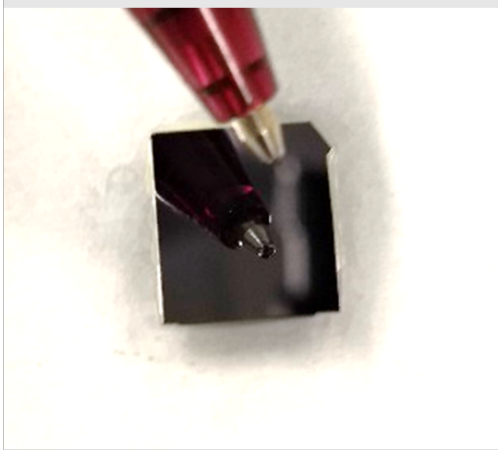
- Plate type: glass non–grooved for wafers <2" diameter; larger wafers are processed using a radial grooved glass plate
- Lapping slurry: 3 µm Al_2O_3& Di H_2O (150 ml abrasive - 1.5 liters Di H_2O)
- Plate speed: 25-30 rpm
- Jig load: 400-600 g

Note:

You should be able to lap your wafer down to 10 µm of the final polished thickness. Final stage would be to remove 10 µm from the wafer using the polishing slurry.

Polishing

- Polishing pad: Chemcloth
- Polishing slurry: CS60 (60 nm particle size)
- Plate speed: 50 - 70 rpm
- Jig load: 400 - 600 g
- Sweep speed: 20 - 100%
- Sweep amplitude: 100%

1 cm x 1 cm InP sample mounted with quartz wax on glass carrier and lapped with 3 µm Al_2O_3& Di H_2O		1 cm x 1 cm InP sample polished on Chemcloth for 20 min using CS60 polishing solutions
	Polishing	

7.3 Gallium Arsenide (GaAs) sample lapping and polishing conditions

Lapping

- Plate type: glass non–grooved for wafers <2" diameter; larger wafers are processed using a radial grooved glass plate
- Lapping slurry: 3 µm Al_2O_3& Di H_2O (150 ml abrasive - 1.5 liters Di H_2O)
- Plate speed: 25-30 rpm
- Jig load: 400-600 g

Note:

You should be able to lap your wafer down to 10 µm of the final polished thickness. Final stage would be to remove 10 µm from the wafer using the polishing slurry.

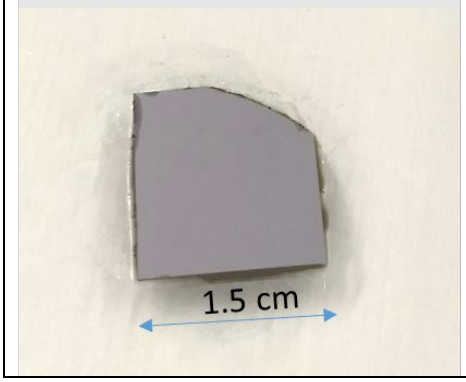
Polishing

- Polishing pad: Chemcloth
- Polishing slurry≈15 ml of 1 µm Al_2O_3 & 150 ml of 3% H_2O_2
- Plate speed: 40 - 50 rpm
- Jig load: 400 - 600 g
- Sweep speed: 20 - 100%
- Sweep amplitude: 100%

Note:

The 1 µm Al_2O_3 is mixed with 3% H2O2 solution in the fume hood and well dispersed by stirring with magnetic stirrer on the plate.

GaAs wafer mounted with quartz wax on glass carrier and lapped with 3 µm Al_2O_3& Di H_2O



Polishing

GaAs wafer polished on Chemcloth for 20 min using a mixture of 1 µm Al_2O_3 & Di H_2O & H_2O_2 polishing solutions