Chemical-Mechanical Polisher

(cmp)

1.0 Title

Chemical-Mechanical Polisher

2.0 Purpose

The Strausbaugh CMP tool is a chemical-mechanical polisher primarily used for polishing polysilicon and silicon dioxide films on 4" and 6" wafers. The system processes wafers serially with manual loading and unloading of each wafer. The chemical-mechanical polishing process uses the combination of chemical and mechanical polishing to planarize wafer surfaces. Materials that can be polished right now are: various oxides, nitride, polysilicon, and polysilicon-germanium. No metal is allowed in CMP as of now.

3.0 Scope

The tool consists of a polishing table, polishing overarm, load/unload station, and pad conditioning device. The load/unload station centers the wafer and holds the wafer with vacuum before the polishing overarm picks up the wafer. The load/unload station also has a sprayer for cleaning the wafer after polishing.

The polishing over arm holds the wafer in the wafer carrier, which includes a pad underneath the wafer. The quill can spray air and water through the pad, or hold the wafer with vacuum. Backpressure is applied during polishing through the holes in the wafer pad.

The polishing over arm can exert down force up to 15 psi, and backpressure up to 1 psi less than the down force (larger back-pressures might blow the wafer off the chuck during polishing, damaging both the machine and the wafer).

The polishing overarm is connected to the overarm spindle and the eccentric wheel, which controls the lateral travel of the arm across the pad during polishing. The travel is set by adjusting a bolt attached to the overarm spindle – this adjustment should only be made by Microlab staff

The polishing pad is glued onto the polishing table. The pad, (we are currently using a IC1000/SUBA IV composite pad) is made of a felt-like material adhered to a stiff back structure.If the pad ever dries out, the residual slurry will stick in the pad fibers and destroy the pad. You will also scratch your wafer if you try to run it again. It is critical that the wafer carrier pad and the polishing pad are never dry.

The conditioning arm is used to condition (brush) the table during or in preparation for wafer polishing. This arm automatically retires to the rinse bowl located behind the machine after polishing is completed.

The slurry consists of DI water, KOH, ~ 200 nm diameter silicon dioxide particles. When the slurry dries it is difficult or impossible to remove, so it is important that all wafer surfaces stay wet until they are properly cleaned.

Wafers are cleaned in CMPWC, a dedicated machine for post-cmp clean. Please refer to its manual (Chapter 10.2) for the operation procedure. In the case CMPWC is down or unavailable, there is a blue box labeled **CMP transfer**. This box can be used to transfer wafers underwater to the Microlab for cleaning after polishing. Cleaning can be done in spindryer 3, recipe 2, or sink 8 piranha and rinse.

4.0 Applicable Documents

Revision History

CMP Process Characterization Report 1999.

5.0 Definitions & Process Terminology

N/A

6.0 Safety

N/A

7.0 Statistical/Process Notes

N/A

8.0 Available Process, Gases, Process Notes

N/A

9.0 Equipment Operation

9.1 Check the machine setup. The label on the machine indicates whether it is set up for either 4" or 6" operation. If change is desired, e-mail cmp@silicon2 and request a tooling change. Be sure to include 4" or 6" in your request. Cmp users will be notified when this change can be made.

9.2 Enable the CMP on the wand.

9.3 The machine should be in the **Wet Idle** process. Press **Stop Wet Idle**, then press **Exit Wet Idle** to exit this mode.

9.4 Log out idle user and log in:

- ► Choose the **Login** from the menu.
- ► Press **Log Off** to log out the user **idle**.
- ► Login with your own username and password.
- ► Make sure the Chuck vacuum meter reads more than 500, otherwise report the fault and refrain from using the tool.

9.5 Prepare the system for polishing:

- ► Turn the valves on the DI water and slurry lines to the slurry configuration as shown on the diagram by the slurry tank.

9.6 Prime slurry lines:

- ► Load recipe: **slurry.prime** -- this recipe is used to prime the lines with slurry.
- ► Go to **Auto** mode -- download recipe.
- ► Make sure table is clear.
- ► Press **start conditioning** button: conditioning arm moves out and onto the table, slurry line begins to dispense. Slurry should start dripping onto the table after ~ 2 minutes. The conditioning ends after three minutes.
- ► No dummy wafer needed for slurry line prime as the polish overarm should stay over the table throughout the process.

9.7 Process your wafers:

- ► You are now ready to process. Go back to recipe page and load **oxide.std.00** (for standard thermal oxide, LTO, PSG polishing on 4") or **6ox6.00** (for standard thermal oxide, LTO, PSG polishing on 6"). Pay close attention to the bottom of the screen as to whether it specifies a 100 or 150 mm wafer thickness.
- ► Go to **Auto** mode -- DO NOT SAVE YOUR RECIPE MODIFICATIONS -- download recipe.

Note: If you need to change any parameter other than the time, you will need prior approval from the staff (see the Appendix).

► Put in your dummy wafer and press **start polish**. After polish is done, wafer will be unloaded in the load station, open the door, rinse the wafer right away, close the door and take the wafer to sinkcmp.

9.8 Clean off all surfaces -- dried slurry is difficult or impossible to clean! If all is fine on your dummy wafer, wait until cmp is done washing the shower head, conditioning the pad and is ready to polish. Load the device wafer and repeat the above.

9.9 Purge slurry lines:

► Turn the valves on the water and slurry lines back to the original configuration as shown on the diagram by the slurry tank (slurry: closed, water: open).

► Go to recipe page, and load **rinse.purge** recipe.

► Go to **Auto** mode, press **start conditioning**.

9.10 Thoroughly rinse the load station, the spindle, and the table. MAKE SURE the **WHOLE** table is covered with water.

9.11 Log out.

9.12 Log in user: idle, password: (blank).

9.13 Go to wet idle page.

9.14 MAKE SURE TO CHECK **Enable Quill Flush**, **Enable Chuck Speed**, **Enable Table Rinse**.

9.15 Press **Start Wet Idle**.

9.16 Disable CMP on the wand.

9.17 See Chapter 10.2 on how to use CMPWC in conjunction with CMP to clean your wafers.

10.0 Troubleshooting

10.1 I forgot to put a wafer on the chuck before starting a recipe; now it is just sitting there looking for a wafer. What do I do?

Press the **Stop polishing** button on the screen. Go to the **Manual** page on the computer, and press the arm position button to move the polish arm back above the table. Now you can open the front door of the chamber and place a wafer on the wafer load chuck, then press **Start Polishing** again.

10.2 There is a wafer on the load chuck, but the machine keeps turning the vacuum on and off, as if it cannot find the wafer.

The vacuum is probably not strong enough. Wait a few seconds and the pump should start to pump down the vacuum chamber.

10.3 I forgot to run the wet idle and then left for the weekend. Is this a problem?

YES -- if the pad ever dries out it must be replaced. This costs ~ $300 for the pad, plus about 3 hours of technician time. **DO NOT FORGET TO RUN THE WET IDLE!**

10.4 Helpful Suggestions (by Emmanuel Quévy, 7/04 and Pejman Monajemi, 7/09)

10.4.1 Local Non-uniformity

Many users complain about non-uniformity, which is really **Within Die Non Uniformity** (WIDNU), not within wafer non-uniformity.

Local non-uniformity occurs because of the uneven distribution of patterns to be planarized (**up areas**) and non-planarized patterns (**down areas**) within the die. This non-uniformity is reproduced everywhere on the wafer, and is really a matter of design. What I did to trick this was that I included dummy structures on my design to roughly get a uniform distribution of Up and Down areas (~ 50%). I got way better results than what I did with previous designs.

But it is still not enough, since I do not have a **hard** etch stop. So, at this point, other parameters to play with are the speed of the pad, and the down force applied. Basically, each design requires a little trimming of the recipe to minimize WIDNU. I can improve that by modifying the recipe a little.

10.4.2 Within Wafer Non-Uniformity

Down force is a very efficient parameter when within wafer uniformity is critical. Less down force, however, produces a lower removal rate but does provide better uniformity. Minimum down force for polish is 4psi.

Example: My run with CMP went absolutely fine. No scratches whatsoever, and the wafers never went off the pad. I planarized 2 µm of SiGe with a removal rate of 0.2 µm/min roughly. Cross wafer and cross load Uniformity is really good (~1%) provided that you rotate your wafer. I did 6 times 2 min, each time rotated the wafer on the load station by 60 degrees.

10.4.3 Monitoring

For any monitoring purpose, I would advise to just run blanket removals on oxide and poly-Si, and measure uniformity using Nanospec to assess the machine is operating as expected.

11.0 Figures & Schematics

N/A

12.0 Appendix

Standard Recipes

oxide.std.00

Step	1	2	3	4	5
Time (sec)	15	5	5	60	15
Down Force (psi)	0	2	6	6	2
Table RPM	100	100	100	100	100
Chuck RPM	10	10	10	10	10
Back Pressure (psi)	-2	-2	-2	1	-2
Table Temp (ºC)	30	30	30	30	30
Slurry 1 (ml/min)	50	50	50	50	0
Rinse (on/off)	off	off	off	off	on

6ox6.00

Step	1	2	3	4	5
Time (sec)	0	15	5	60	4
Down Force (psi)	0	0	3	6	0
Table RPM	33	33	33	33	15
Chuck RPM	15	15	15	15	15
Back Pressure (psi)	-2	-2	-2	2	-2
Table Temp (ºC)	30	30	30	30	30
Slurry 1 (ml/min)	50	100	100	125	0
Rinse (on/off)	off	Off	off	off	on

Poly.polish

Step	1	2	3	4
Time (sec)	15	2	20	5
Down Force (psi)	0	5	8	0
Table RPM	24	24	24	24
Chuck RPM	6	6	6	6
Back Pressure (psi)	-2	-1	1	-2
Table Temp (ºC)	30	30	30	30
Slurry 1 (ml/min)	100	100	100	100
Rinse (on/off)	off	off	off	on

rinse.purge

Step	1
Time (sec)	240
Down Force (psi)	0.5
Table RPM	25
Chuck RPM	15
Back Pressure (psi)	-2
Table Temp (ºC)	30
Slurry 1 (ml/min)	250
Rinse (on/off)	on

slurry1.prime

Step	1
Time (sec)	180
Down Force (psi)	0.5
Table RPM	25
Chuck RPM	15
Back Pressure (psi)	-2
Table Temp (ºC)	30
Slurry 1 (ml/min)	250
Rinse (on/off)	on

Note: The only parameter a user is allowed to change is the polish time. When you change the polish time for your process, please DO NOT save the changed recipe. If you would like to experiment with the other parameters, please contact the process staff to approve your plan.

CMP Study Guide

Be sure to know...

1. Functions of the load/unload station.
2. Reasons to avoid letting wafers and polishing pad dry.
3. Exiting wet idle.
4. What Start Conditioning accomplishes.
5. Choosing the proper recipe.
6. Recipe modifications.
7. Purging the slurry line.
8. What to check before leaving machine in wet idle.
9. Troubleshooting vacuum problems.
10. Materials you are allowed to polish.
11. Forgetting to put a wafer on.
12. Troubleshooting spider arm problems.
13. What happens if you open the door during polishing.
14. Dealing with a wafer that has slipped out during polishing.
15. Cleaning a cmp-polished wafer.