

<b>Tool Identifier</b>	<b>Pyrogenic Oxide</b>
<b>Document version:</b>	<b>1.0</b>
<b>Documented by</b>	<b>Manali Khare</b>



## People List

<b>Role</b>	<b>Name</b>	<b>Email ID</b>	<b>Mobile no.</b>
System Owner	Manali, Neha	<a href="mailto:khare.manali1@gmail.com">khare.manali1@gmail.com</a> <a href="mailto:neharaorane.171@gmail.com">neharaorane.171@gmail.com</a>	9766769611
Authorised User	Anjum Ahmed	<a href="mailto:anjum04@gmail.com">anjum04@gmail.com</a>	9920470606
Authorised User	Kalaivani	<a href="mailto:vaniece88@gmail.com">vaniece88@gmail.com</a>	8879261834
Authorised User	Poonam Jangid	<a href="mailto:poonamjngd@gmail.com">poonamjngd@gmail.com</a>	9414977832
Authorised User	Robin Singla	<a href="mailto:robinsingla.eng@gmail.com">robinsingla.eng@gmail.com</a>	
Authorised User	Pradeep	<a href="mailto:pradeeprn@ee.iitb.ac.in">pradeeprn@ee.iitb.ac.in</a>	9920190630
Authorised User	Sandeep	<a href="mailto:sandeepm@ee.iitb.ac.in">sandeepm@ee.iitb.ac.in</a>	9867634828
People authorised to handle gas cylinders	Pradeep Sandeep	<a href="mailto:pradeeprn@ee.iitb.ac.in">pradeeprn@ee.iitb.ac.in</a> <a href="mailto:sandeepm@ee.iitb.ac.in">sandeepm@ee.iitb.ac.in</a>	

## **Training Procedure and Authorization:**

1. Send a mail to the system owner along with the faculty incharge of the tool and the guide stating all the details.
2. Get through with the training notes to understand the system and participate in 3-4 process runs with the system owner or existing authorized user.
3. To get authorization s/he must do 2-3 process runs on her/his own in presence of system owner and also answer and demonstrate the questions asked by system owner through operation of the system.

## **Violation policy:**

1. The authorized user must follow the clean room protocol.
2. It is mandatory to follow the things mentioned in page 4 “THINGS MUST FOLLOW”.
3. H/she should ensure smooth operation of the system during their use. If any authorized user found to violate any of above mentioned rules, her/his authorization will be cancelled and they will be required to go through the authorization process again.

## **THINGS MUST FOLLOW:**

- **NEVER** touch boats or wafers with your hands even if you are wearing gloves. Use **ONLY** the appropriate boat holder. Boat Holder must be clean also.
- Use **ONLY** clean tweezers or vacuum wand dedicated for that tube. Clean these implements often using isopropyl alcohol, DI water and clean wipes.
- **ALWAYS** clean wafers using either piranha or RCA type clean right before loading them into the tube. Wafers must be clean and dry. Use spin rinse dryer whenever possible. Never load a contaminated wafer or boat into the tube as this will contaminate the tube as well.
- Wafers and boats coming out of the tube are extremely hot. Do **NOT** set them on clean wipes, vinyl gloves or anything else which will melt. Set hot items on clean stainless steel bench or on dedicated quartz carrier.
- **ALWAYS** wear a face mask when loading and unloading your wafers into tube to minimize contamination from your breath.
- **ALWAYS** minimize the time that the boat and loader remains out of the furnace and makes sure the purge nitrogen is set to 5.0 liters or better to keep room air out of the tube.
- **ALWAYS** store dummy wafers in the tube which they are assigned. Dummy wafers not needed for a run, may be safely stored at the load station in a clean quartz carrier. Promptly return dummies back to the appropriate tube when your run is finished.
- **ALWAYS** book the slot before starting the process and activate it and fill in the required details in the log book without fail.

## **Specifications**

- **Substrate:** Si only.
- **Substrate size:** 4" only.
- **Types of depositions:** Wet oxide
- **Pressure range :** Atmospheric pressure
- **Temperature range:** upto 1100oC
- **Gases presently connected to system:** O2, H2
- **Mass Flow Controller (MFC) Limit/Range :**  
**O2:** 6000 sccm, **H2:** 8000 sccm

## **Operating Procedure**

### **Things needed before entering the clean room**

1. Switch On the mains.
2. Ensure that the heater switches in ON position.
3. Check for the nitrogen pressure denoted by **furnace gas cabinet**. Minimum 4 bar pressure is required for smooth operation.
4. Check for the Oxygen and Hydrogen gases. Ask PRADEEP or SANDEEP to open these gas valves. Minimum 2 bar pressure is required for smooth operation.
5. Ensure that the exhaust is ON. Contact PRADEEP or SANDEEP.

### **SWITCH ON Procedure after entering the clean room**

6. Check the Log book for any remarks from the previous run. Contact system owner if any remarks have been written.
7. Book the slot on the slot booking interface and activate it. (Make sure no process is running on any other tube of the same stack. If yes then wait till the other tube's temperature ramps down)
8. Press the GREEN push button switch located right to the touch screen.(If any alarm comes, the alarm page automatically displayed without login)
9. Click on LOGIN and enter the password by using the on-screen key board.
10. Press ENTER.
11. Click on "Pyrogenic oxide" button on the top tool bar. The OVERVIEW page is displayed.
12. Do not change the settings in the CONFIGURATION page. Contact system owner if it is required.

### **Editing the RECIPE**

13. Go to RECIPE page by pressing the "RECIPE" button located on the bottom tool bar.
14. Press OPEN located at the top right corner for 2 seconds. A beep will be heard and some of the cells in the recipe page will be highlighted in green background.
15. Click on the cell to change its value. A small pop up key pad is displayed.
16. Enter the required value (within operational limits) and Press ENTER Press the cell once to change it into YES and vice-versa.
17. Set the BOAT CONTROL to IN in pre-standby step.
18. After editing all the cells press the SAVE button in the RECIPE page for 2 seconds.
19. Press OPEN once again to make the current recipe as active.

## **Boat-Out and Loading the wafers**

20. After saving the recipe press OPERATION button located on the bottom tool bar.
21. Now press the BOAT-OUT button. It will take 2-3 minutes for complete boat out.
22. Load the Cleaned wafers between the dummy wafers in the required slots. **Make sure that the wafers are loaded in alternate slots.** Try to place the wafers at the slots in the center of the boat. Handle the wafers with care and do not touch the wafer boat and process tube interior with gloves. **Make sure that the primary flat of the wafer is in upward direction and the polished side is facing towards the left while loading the wafers.**

## **Running the Recipe**

23. Ensure that the recipe is saved after editing.
24. Press OVERVIEW button located at the bottom left corner.
25. Now press RUN on the top left located below the top tool bar and the RUN button starts blinking indicated that the process is started.
26. During process if any alarm comes refer Alarms page for corresponding action.

## **SHUTTING DOWN THE SYSTEM**

1. Do not switch off the mains power directly from outside in any case (Power failure is exceptional).
2. Wait for the temperature of the three zones to ramp down up to 200oC.
3. Press SHUT DOWN located on the top right corner. A small pop up window with RUN and CLOSE buttons is displayed.
4. Press RUN (in the pop up window). The Shut down in the pop up window starts blinking.
5. After 2-3 minutes, the blinking stops.
6. Press the RED push button located to right of the touch screen.

## **Check List before Leaving the System**

1. Make entry in the log book with all the required details including the expected thickness and the thickness obtained after measuring with ellipsometry.
2. Let N2 gas be flowing during ramp down.

## **Alarms**

1. Tube 1 process escaped the limit of gas flow

Indication: ORANGE indicator flashes.

Reason: Either the H<sub>2</sub> or the O<sub>2</sub> gas flow is inappropriate.

Action: Abort the recipe, tell the facility people to check the gases, then check data logging page and see for how much time did the recipe run and accordingly make changes in the recipe time and run the recipe.

These are the generally observed alarm during process run. If you observe any alarm other than those described above please contact the system owner.

### Thickness vs Time data

We have examined all available entries from system log book from 01/12/2011 to 23/09/2013 and plotted this data as oxide thickness vs time of oxidation. The oxidation was performed at 1000°C tube temperature and 735°C torch temperature with hydrogen & oxygen gas concentration of 8000 and 6000 sccm respectively. The polynomial fit of this curve approximately follows **Deal-Grove model** of thermal oxidation for Silicon.

The best fit for the thickness obtained is:-

$$x = 0.1304t - 3.97t^2 - 44.07$$

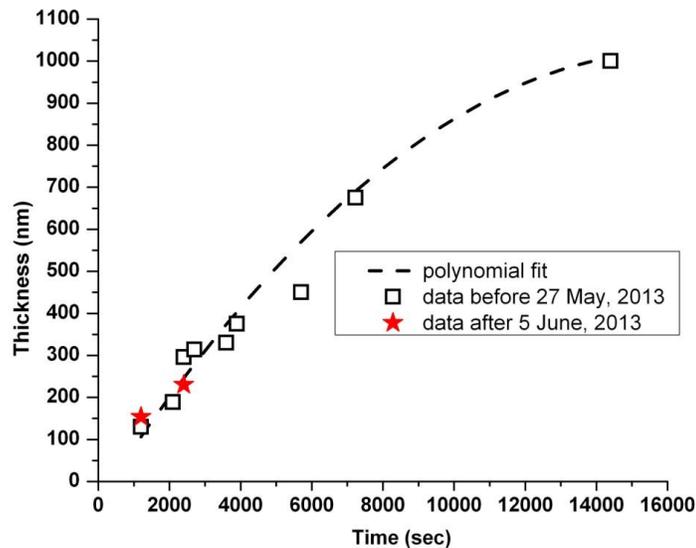
Where,

x = oxide thickness in nm

t = time of oxidation in seconds

From 27 May, 2013 to 5 June, 2013 system was down and during this period company engineer did AMC (tube cleaning). Red star in the plot are for the data after AMC which seems to follow fitted curve.

User can design their experiments using this equation with an approximate error of ±10%.



***It is mandatory for all users to do Ellipsometry immediately after oxidation and enter the actual oxide thickness in the Pyrogenic Oxide Furnace log book along with the relevant process parameters.***

**Data to be entered in the log book**

1. Authorised user name
2. User name
3. Project code
4. Guide
5. Department
6. Process start time
7. Process end time
8. H2 flow
9. O2 flow
10. Process time (sec)
11. Process temp.
12. Torch temp.
13. No. of samples
14. Expected thickness
15. Thickness measured with ellipsometry at different positions (center, left, right, top, bottom)
16. Average measured thickness
17. Slot no. used for wafers
18. Remarks

