

# University of Minnesota Nano Fabrication Center

## Standard Operating Procedure

**Equipment Name:** LPCVD system

**Coral Name:** Low Pressure CVD

**Revision Number:** 3

**Model:** SEMY

**Revisionist:** Tony Whipple

**Location:** Bay 1

**Date:** 2/1/07

### 1 Description

The LPCVD system is a stack or cabinet that holds four horizontal tubes that each runs a separate process. Four tubes each is a large quartz tube that is sealed at the front with a door while the back of the tube is connected to a vacuum pump. Around each quartz tube is heating elements that heat the tube and its contents up to the correct temperature. With a vacuum in the tube and at the correct temperature, the gases are entered into the tube. The heat causes the gases to react and a film is deposited. The amount of film is determined by the amount of time the gas step is ran into the tube.

### 2 Safety

- a The main item here is there is several gases used here that are dangerous.
- b Electrical hazard since this system uses high voltage/current to power the elements.
- c High temperature is a concern, as the tubes open at temperatures over 600 degrees.
- d The danger of vacuum and the quartz ware if the quartz was to break.

### 3 Restrictions/Requirements

- a Must be a qualified user for this system.

**To prevent wafers from contaminating the tubes and other user's wafers and large cost:**

#### **READ THIS:**

There are to be **NO** wafers that **EVER** had metal on them, or have been in any of the following systems:

- PECVD
- RTA
- Sputtering systems
- Electron-beam deposition systems
- Alloy tube 24

General Restrictions:

- Do NOT write on the back of the wafers with any type of the Magic marker, or Sharpie.
- If the wafers have been processed in the Alloy tube 24, they can not be processed through any other tube.
- Wafer cleanliness: All wafers that are to be processed in the system **MUST** be clean and free of anything that is not a normal semiconductor material. All resist need to be cleaned from the wafer. Washing it off with solvents is not good enough; a clean in the sulfuric acid bath in bay 1 must be done. Some users might want to follow this clean step with doing an RCA clean before loading the wafers into the Tylan system. The cleaner the wafer, the better the film will be. Do not touch with hands the wafers that are to be loaded into the system and **DO NOT** touch the quartz and SiC boats.
- Wafers that have been in the Tylan tubes can be processed in any of the LPCVD tubes.
- Wafers from the top three tubes can be ran into the LPCVD for processing.
- Wafers from tube 24 **CANNOT** be subsequently processed in the LPCVD.

### 4 Required Facilities

- a Compressed air 60psi
- b Process chilled water
- c Nitrogen gas

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### 5 Definitions

- a ESW Sun computer: The computer that is the operator interface.
- b Mypro: This is the tube computer that controls only one tube.
- c Boat: This is the quartz container that holds the wafers
- d SiC paddle: This is the long support that holds the boat as it goes into the tube.

### 6 Setup

- a Make sure that you have your wafer ready to go which is clean and ready to load. If you need a test wafer to run during the poly deposition contact a staff person.
- b Reserve you time for the system if needed.
- c Enable the system by using **CORAL**
- d The system can only be used Monday – Friday from 7:00 AM to 5:00 PM

### 7 Operating Instructions

- a First Enable the tube to be used in **CORAL**. Start to enter data in log book for the tube.
- b The first item is to go to the ESW terminal and make sure it is ready to run. If the ESW is not ready, as in the screen is locked, contact a NFC staff person. If the screen does not display the **Sentinel** box you may need to start it running by clicking on Icon at the bottom task bar. If the **Sentinel** palette is on the screen, you need to log in by clicking the upper left **FILE**. Enter the user name and password which is: **nfc** and **nfc1234** in lower case.( Fig. 1.) Click on the Icon labeled **MYPRO** this will bring up a new box with three icons. ( Fig. 3.)

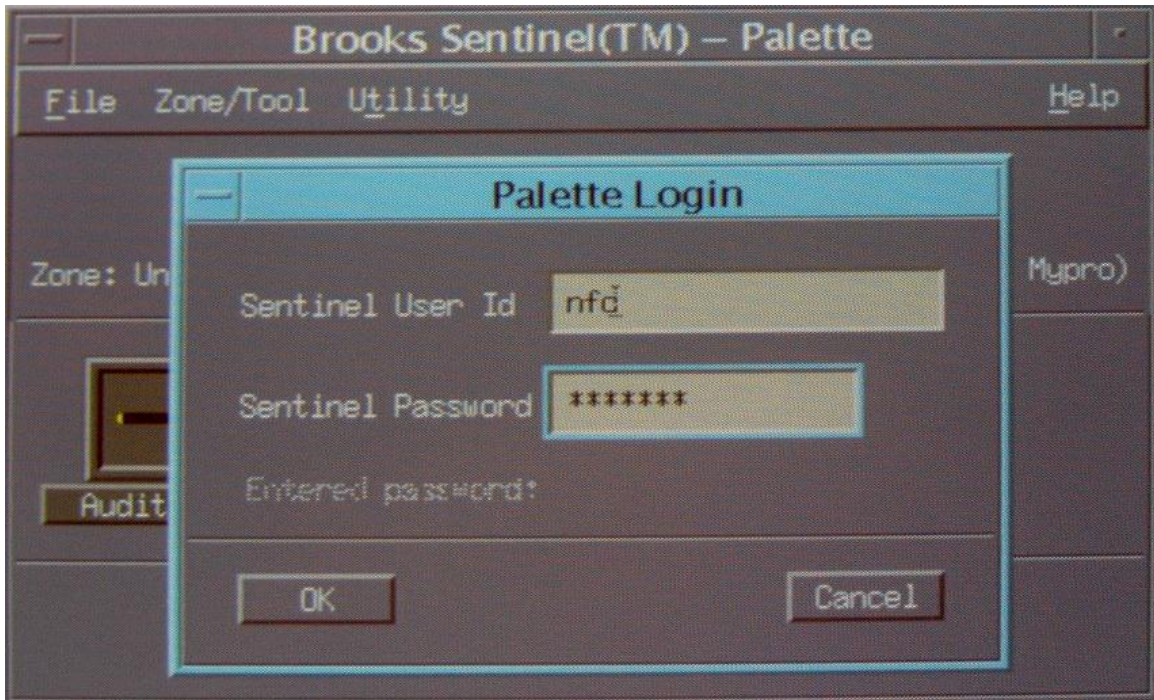
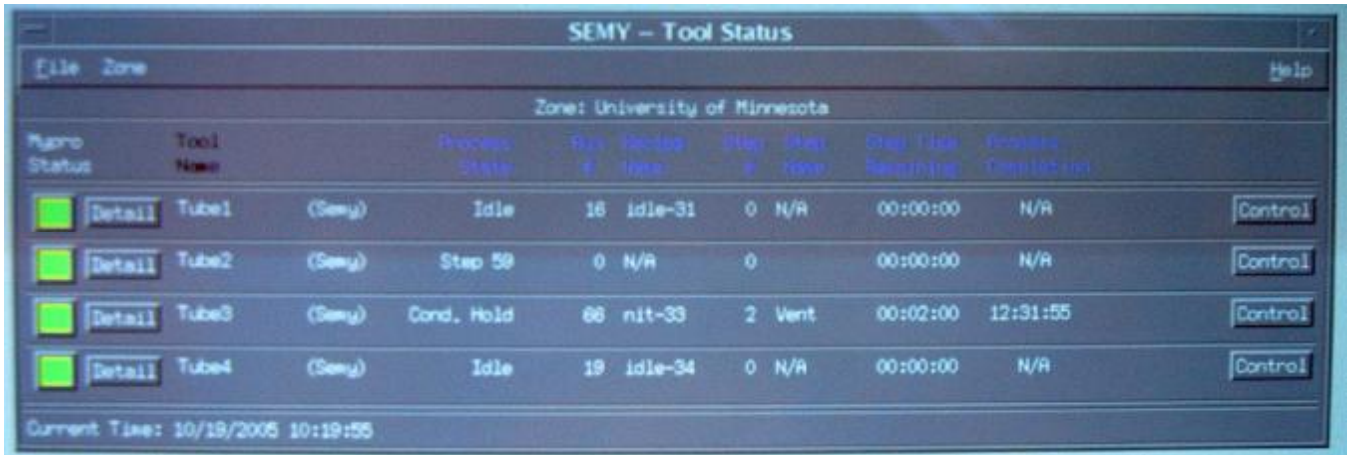


Fig. 1 Login screen that starts the Sentinel software.

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- c Find the icon labeled **Tube Status** on the screen and click on it. ( Fig 2.)



The screenshot shows the 'SEMY - Tool Status' window. It has a menu bar with 'File', 'Zone', and 'Help'. Below the menu bar, it says 'Zone: University of Minnesota'. The main area is a table with columns: 'Pump Status', 'Tool Name', 'Process State', 'Run #', 'Recipe', 'Step #', 'Step Name', 'Step Time Remaining', and 'Process Completed on'. There are four rows of data for Tube1, Tube2, Tube3, and Tube4. Each row has a green square icon to the left of the 'Tool Name' column and a 'Control' button to the right. At the bottom, it says 'Current Time: 10/19/2006 10:19:55'.

Pump Status	Tool Name	Process State	Run #	Recipe	Step #	Step Name	Step Time Remaining	Process Completed on
Green	Tube1 (Semj)	Idle	18	idle-31	0	N/A	00:00:00	N/A
Green	Tube2 (Semj)	Step 59	0	N/A	0		00:00:00	N/A
Green	Tube3 (Semj)	Cond. Hold	86	nit-33	2	Vent	00:02:00	12:31:55
Green	Tube4 (Semj)	Idle	19	idle-34	0	N/A	00:00:00	N/A

Fig. 2 Check the status of the tube you want to use.

- d Check to see if the box on the far left is colored **GREEN** and it says **Idle** under the label **Process State** for the tube you want to run. If it is not idle but says step 59 under Process state this is being worked on by maintenance.
- e Click on the icon called **Run Tool** on the screen and click on it. This is used to select a recipe. A new box will open where all the recipes are that can be ran. ( Fig. 4.)



Fig. 3. Run Tool and Tool Status icons.

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- f Make sure the small box in the upper left is the **Production** button if it is not displayed.
- g Select the minispec from the list which is planned to be ran. The recipe name you want.
- h This will cause a recipe to appear on the right, click the diamond under tool, it turns **RED**.
- i Now click on the **Run Minispec** button at the top to start loading this recipe.



Fig. 4. The recipe and tube has been selected and the next thing is to select “Run Minispec”.

- j A new window will open labeled: **Run Tool Login** (Fig. 5.)

- k Complete the information for the page: User Id **nfc** Password **nfc1234**

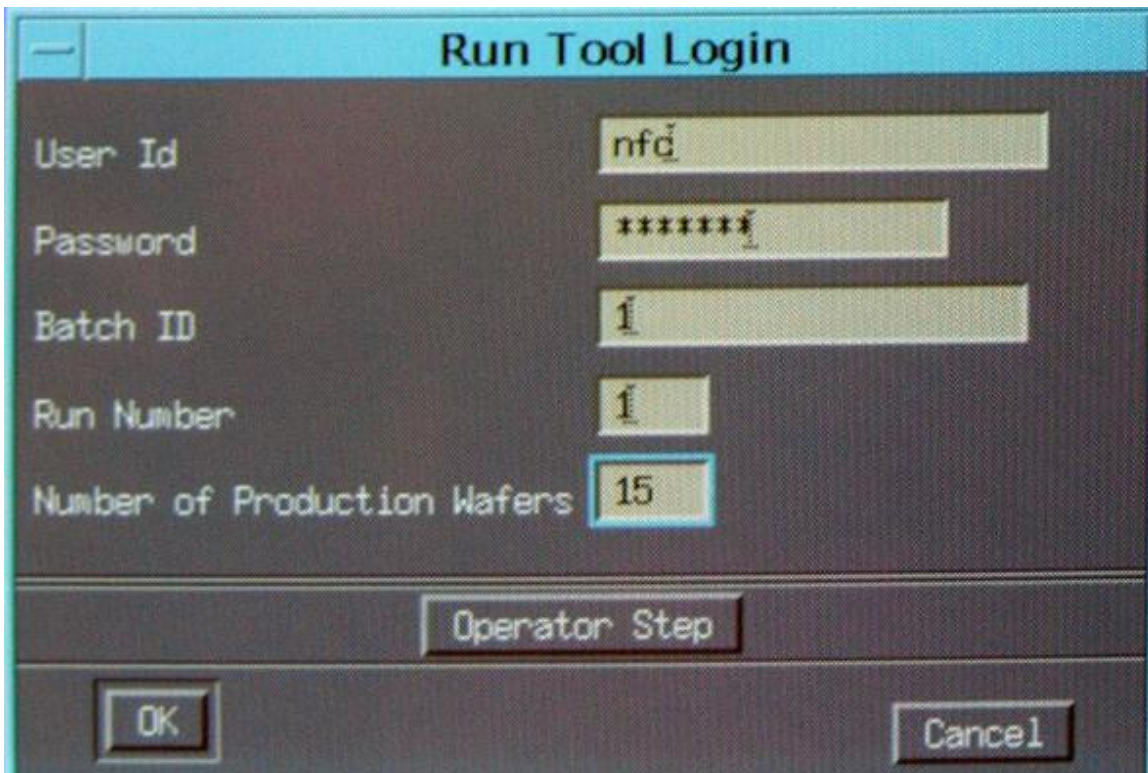


Fig. 5. The run tool login info with user and password info being entered.

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- 1 After completing the info the next item is to click on the **Operator** Step box. This will have another box appear. This is the delay time ( Deposit Time) that you will need to enter. There is a limit of 6 hours of total time that can be entered, if you need more time contact NFC staff for more information. ( Fig. 6.)



Fig. 6. The operator step, which is the delay time will determine the resulting film thickness.

- m Clicking **OK** on the operator step, this will display a small box that gives a brief review of the data you entered, check this to make sure you have the correct recipe and operator step time. Then click **OK** again. ( Fig. 7.)

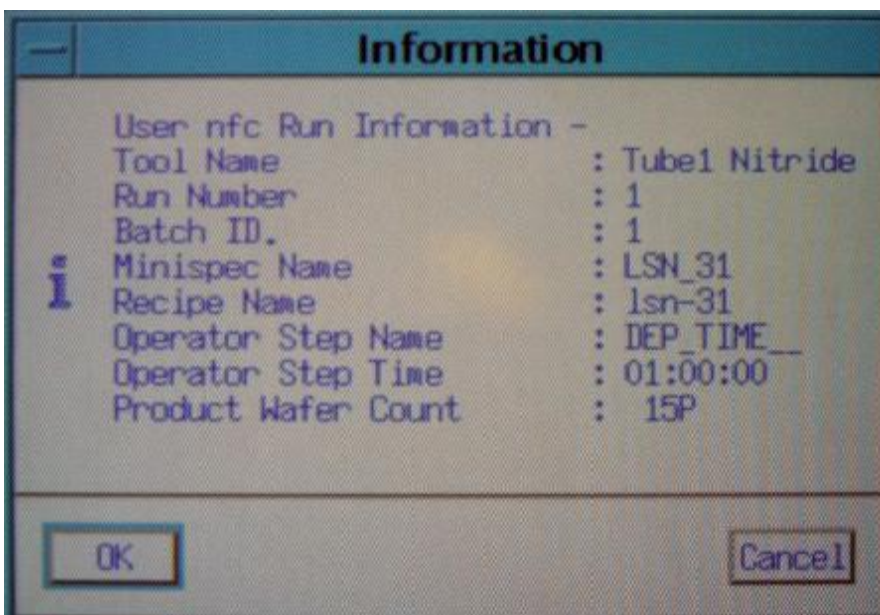


Fig 7. A review of the data entered for the minispec to be ran.

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- n The data and recipe will be downloaded to the tube computer at which time you can then exit from the Run Tool screen, just click on the **File** and select **exit**. Next look at the **Tool Status** and you should see the tube will now have a new recipe listed for the tube selected. Click on the **Control** Icon for that tube and a small box will appear. Press the **START** button and the control screen should now display the word running for the selected tube. In a few seconds the tube will go in HOLD, Press **HOLD** to have it continue. Press the **Cancel** bar at the bottom to remove the box, to avoid having the **Abort** button being pressed by mistake. You must have the box closed before being able to select other tubes. (Fig. 8)

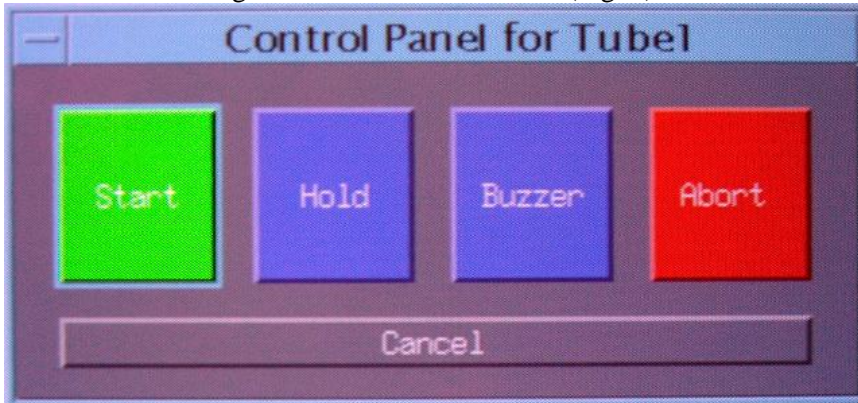


Fig. 8. Control panel listing the four items that can be controlled for each tube.

- o The other button that can be selected on the left side of **Tool Display** screen is **Detail**, this displays the actual analog and digital values for the tube. Click this to watch the actual values. The **Detail** screen and the **Tool Display** screen is all the information needed to process a run

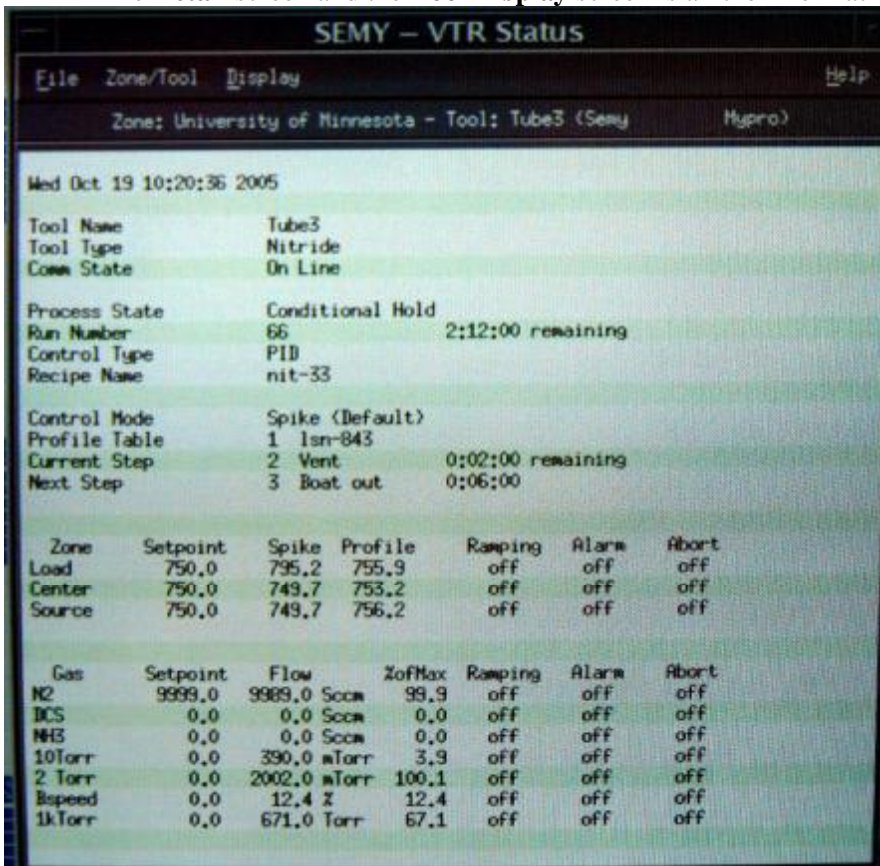


Fig. 9 The detail screen displays many useful items about the tube.

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- p The program will run and the first thing is that the tube will check on things and if it is okay it will go to the next step which is a **HOLD** step. This is waiting on you to say “that it is okay to open”, all recipes wait for you to say it is okay to open. No recipe will open a tube by itself. Notice the **Tool Status** will display the word **HOLD** for the tube. Open the **Control Panel** for the tube and press the **HOLD** button and the **Buzzer** button too. Close the **Control Panel** when you are done.
- q The tube will vent and open and will stop with the loader open waiting for you to load your wafers. Again Do NOT place the boats any where except the allowed placements areas! Load your wafers in a safe and orderly manner. Take care to not allow your gloves or cleanroom gown to touch the boats nor the paddle, as they will be hot. Fill log book, with Process time! In case there is an error and NFC staff can fix the problem we will need to know the process parameters.
- r Once the wafers are loaded, click on the **HOLD** for the tube again, the loader will close the tube, watch for the loader to make sure the IN LED is lit when the tube is closed



Fig. 9 The boat loader is closed, as the IN LED is lit, things are working correctly.

- s You can watch the detail screen to see the pressure of the tube go down and the temperature go to the correct value and gases turn on for the needed time and later the once the time is completed the gas will be purged from the tube and temperature will go down and the tube will be ready to unload and waiting at a **HOLD** step again.
- t Press the **HOLD** button again, unload your wafers. Press **HOLD** again to close the tube. Once the tube is closed watch to make sure the IN LED is lit and it is pumping down correctly.
- u Once the tube has pumped down correctly, and process state is **IDLE**, load and run **IDLE-xx** recipe for the tube. Now you can log out of the tube on Coral.

### 8 Problems/Troubleshooting

- Tube closed but the IN LED is not lit.

Click the loader switch to the **LOAD** position for ~ 2 seconds and then move it back to the **AUTO** position. If this did not help contact NFC staff immediately.

-Red alarm is display.

Check the alarm, if the process gas and temperature values are normal, and the process did not abort continue running, if the values are wrong or the system aborted, contact NFC staff. Record dep time too.

- The screen saver is on and it asks for a password.

Ask for a NFC staff person to get the system running.

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### 9 Process recipe list

There are four process LPCVD tubes:

Tube 31 Low stress Nitride only 4 and 6 inch wafers.

Tube 32 Poly silicon

Tube 33 Regular and low stress Nitride

Tube 34 LTO, PSG, and BPSG

Tube	Recipe	Dep rate	Uniformity within wafer	Across boat
Tube 31	LSN-31	Still testing	Still testing	Still testing
Tube 32				
	POLY-SIL	92 to 96 Ang/min	0.9% in wafer	3% boat
	PHOSPOLY	25 to 16 Ang/min	~ 10% in wafer	
	ASIL-550	~ 10 Ang min	~ 1 in wafer	
Tube 33				
	LSN-33	~ 28 to 36 Ang/min	~ 22% in wafer	~12% boat
	NIT-33	~ 41 Ang /min	~ 4% in wafer	~9% boat
Tube 34				
	LTO	86 Ang/min	~ 12% in wafer	~ 3 % boat
	PSG	~80 Ang/min	~ 15% in wafer	~ 4 % boat
	BPSG			

Tube 33 LSN-33 stress values are in the range of 100 MPa +/- 50

### APPENDIX:

#### Allowed and prohibited processing and materials

##### Only these materials are allowed into the LPCVD tubes:

- New silicon wafers
- Wafers that have been previously processed in one of the top three Tylan tubes
- Wafers after ion implantation
- Other LPCVD films
- Wafers after cleaning RCA or piranha ( $H_2SO_4 + H_2O_2$ ) cleaning in Bay 1 wet benches

Wafers after lithography steps or dry etching in STS or Deep trench etcher (These wafers must have a piranha clean on the wafers first)

##### **NOT** allowed in the LPCVD tubes:

If wafers were ran in Alloy tube, RTA, metal deposition systems, PECVD, or was contaminated with any film, or was even handled with bare hands. Any of these things will contaminate the tube and cause many parts to be replaced. Not to mention the chance of contaminating someone else wafers, or other process equipment.