Unaxis 790
Plasma Enhanced Chemical Vapor Deposition
(PECVD)

University of Notre Dame
Department of Electrical Engineering

General Precautions

Contacts

For problems, clarification of procedures, or general information pertaining to this machine please contact lab staff at **staff-ndnf-list@nd.edu**.

In Case of Emergency, Please Contact Notre Dame Security at

911

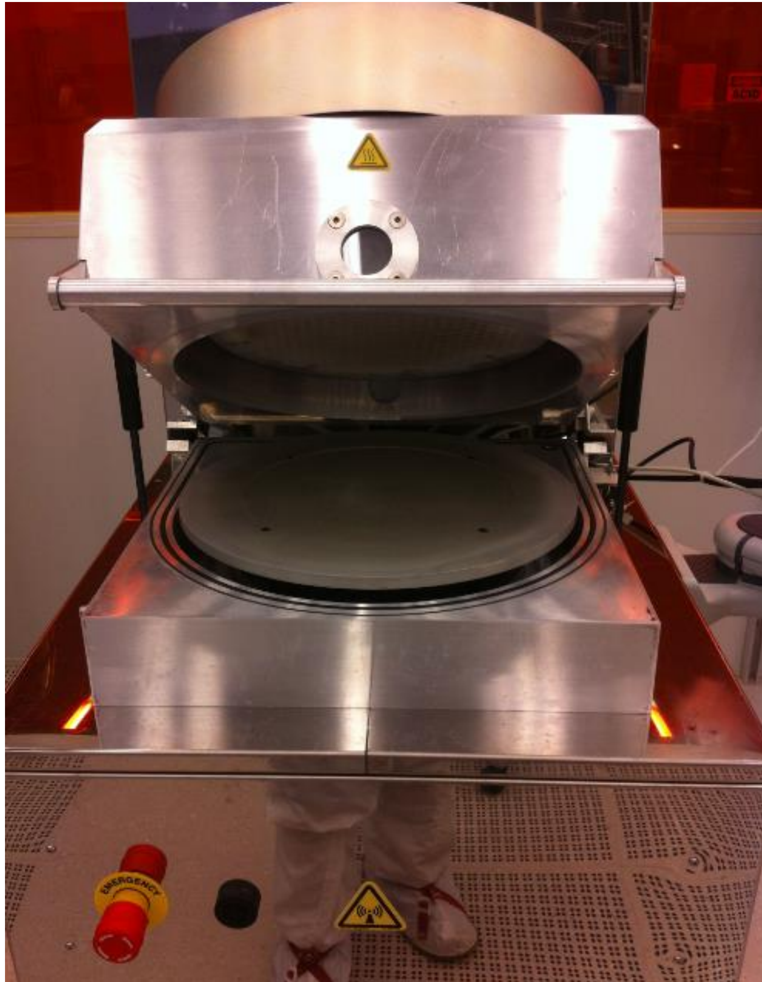
If any step does not respond as it should, stop and put the machine into standby if you can and contact help. If unsure on how to get to standby mode safely, leave the machine as it is and contact above personnel.

General Access

Login: **ICFab**
Password: **ICFab**

CAUTION!

Substrate is extremely HOT and can be opened at temperatures up to 350 ^{o}C. **ALWAYS VERIFY** the lid is open fully and able to **STAY OPEN** before placing hands inside system. You **HAVE TO** hold the handle by one hand while loading / unloading wafers.

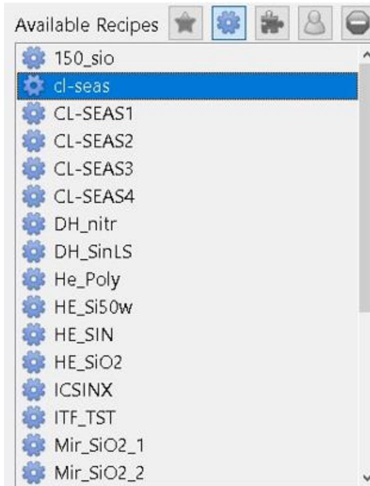


Operation Instructions:

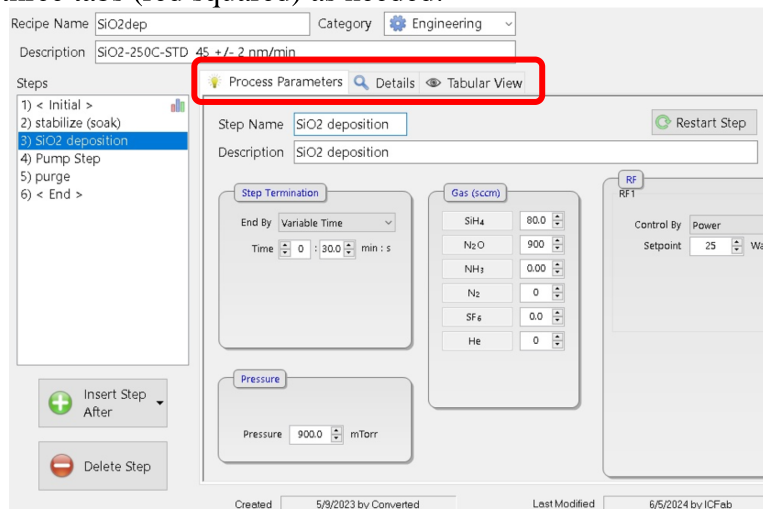
1. Standby condition check: under the **Process – Create Job** tab, verify the following parameters:
    a. chamber vacuum (chamber lid closed) reads 5 mT
    b. actual temp of Heat Exchanger and Substrate be at 35 °C and 120 °C

2. iLab login
    a. **Schedule Equipment** tab → **Go to Kiosk** → **Start** your section. If you are 15 mins late than your reservation start time, you can Start Walkup Session.
    b. **Cumulative Thickness** Check from last user's note.
    If it is equal or close to the limit (10,000 Å), you **HAVE TO** run one of five clean-seasoning recipes listed in step 3-a, based on your desired material and temperature, **BEFORE** running any other recipe. For example, if you want to deposit SiO_2 at 250 °C after clean & seasoning, choose the recipe cl-seas.

3. Load Recipe
    a. If Chamber clean is needed – select one of the 5 standard clean-seasoning recipes:
        - CL-SEAS – for SiO_2 at 250 °C
        - CL-SEAS1 – for SiO_2 at 350 °C
        - CL-SEAS2 – for Si_3N_4 at 250 °C
        - CL-SEAS3 – for Si_3N_4 at 300 °C
        - CL-SEAS4 – for Si_3N_4 at 350 °C
    b. If chamber clean is not needed, go ahead to select the desired recipe from the list. Use only **Engineering** type filter: Engineering



c. If you need to check the parameters of a recipe, go the **Recipes** tab, then **Load…** button to select the recipe, all steps are listed in the **Steps** box. Go over the three tabs (red squared) as needed:



Note that the deposition step time will be input right before the recipe starts, so one doesn't need to change the default 30s on this page.

d. If all parameters look good, go back to **Process – Create Job** tab, MAKE SURE the desired recipe is selected from the list, then click on the **Set Recipe Temps** button and wait until the temps are both in compliance (~30 min for ramping to 250 ºC).

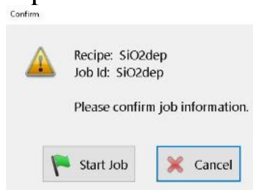
4. <u>Sample Load</u>

a. Once the temps are in compliance, under the **Process – Create Job** tab

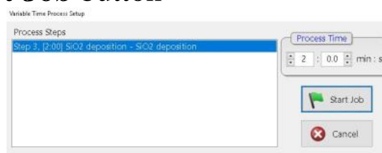
- Click on the **Vent Chamber** button, and wait until the chamber is fully vented;
- Open Lid – lift the bar until the lid reach the up-limit position, verify that the lid stays open on its own by two shocks;
- **HOLD ON** the bar using one hand while putting the sample at the center of platen. CAUTION - PLATEN IS VERY HOT!!!!

- NOTE: don’t scratch the platen surface by the tweezer!
- **Gently** Close the Lid
    - DON’T smash the heavy lid on the chamber base.
- While holding down on handle by one hand, click on the **Pump Chamber** button;
- Allow pressure goes to < 10 mT (should be reading 5 mT quickly from the Process Manometer)

5. Running the recipe
    a. Under the **Process – Create Job** tab, click on **Start Job** button
    b. A confirmation window pops up like below and click on **Start Job** button:



    c. Set the desired time duration in the process step in the following window. **Verify** the time in the left bracket matches value in the input boxes on the right, then click on **Start Job** button



    d. Allow Process to complete;

6. Remove sample (See step 4 above).

7. Place system back into standby condition
    a. under the **Process-Create Job** tab, click on the **Set Standby Temps** button, **verify** the set points for heat exchanger and substrate is 35 and 120 degrees respectively.
    b. Temp will decrease back to standby defaults

8. Finish up
    a. Disable iLab session from Kiosk and go to your reservation page again to leave a note of the cumulative thickness. **Don’t forget it!** This value is required for the next user to determine if a clean-season session is needed.
    b. Clean up the operating desk before you leave.

Clean and Season

All the 5 CL-SEASX.PRC recipes are two step recipes. Step 1 will perform a 10-minute SF_6/N_2O clean of the chamber. The cumulative thickness at the conclusion of this first step is now 0 Å. The second step of the recipe will deposit ~1000 Å of the desired film (SiO_2 or Si_3N_4) at the desired temperature selected. The cumulative thickness at the conclusion of this second's step is now 1000 Å.

Standard Process Recipes

- SINX.PRC – Silicon Nitride at 250 ^oC - Dep rate 160 +/- 20 Å/min
- SINX6.PRC – Silicon Nitride at 350 ^oC
- SIO2DEP.PRC – Silicon Dioxide at 250 ^oC – Dep rate 450 +/- 20 Å/min
    - Above rates calibrated at May, 2023

Si_3N_4 Standard Process Parameters:

SiH_4 – 60 sccm
NH_3 – 7.5 sccm
N_2 – 1000 sccm
Pressure – 1300 mT
Heat Exchanger – 60 ^oC
Substrate – 250 ^oC
Power – 25 W

SiO_2 Standard Process Parameters:

SiH_4 – 80 sccm
N_2O – 900 sccm
Pressure – 900 mT
Heat Exchanger – 60 ^oC
Substrate – 250 ^oC
Power – 25 W

Appendix:

Optical Properties of PECVD Films

Optical Properties of PECVD Silicon Nitride

(Measured by WVASE 32)

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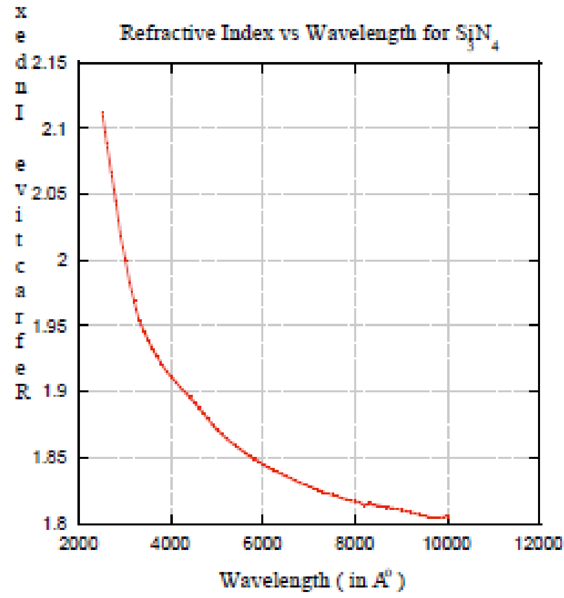

Figure 1. PECVD Silicon Nitride Refractive Index (n)

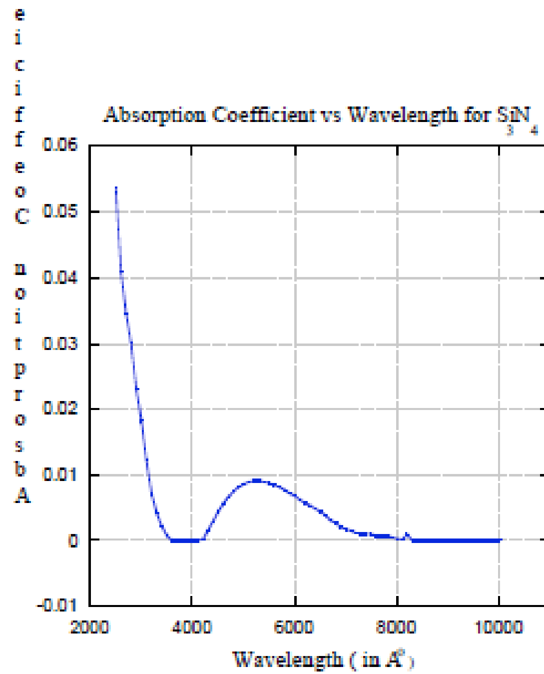

Figure 2. PECVD Silicon Nitride Absorption Coefficient (k)

Optical Properties of PECVD Silicon Dioxide
(Measured by WVASE 32)

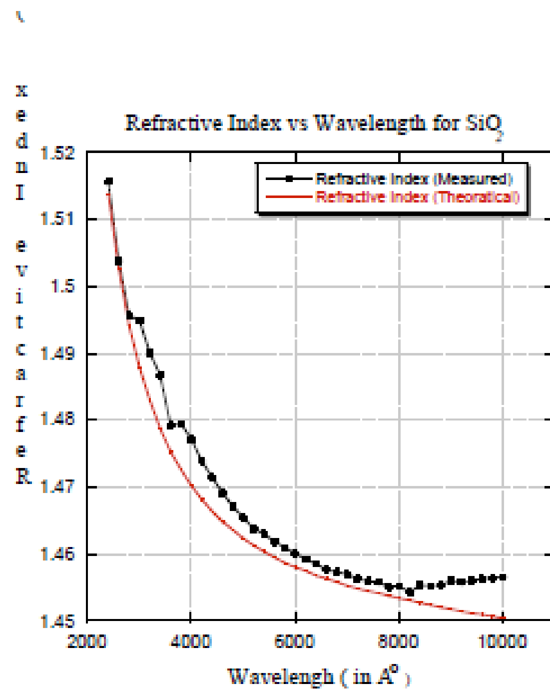

Figure 3. Silicon dioxide refractive index. Comparison of PECVD and thermal oxide values.

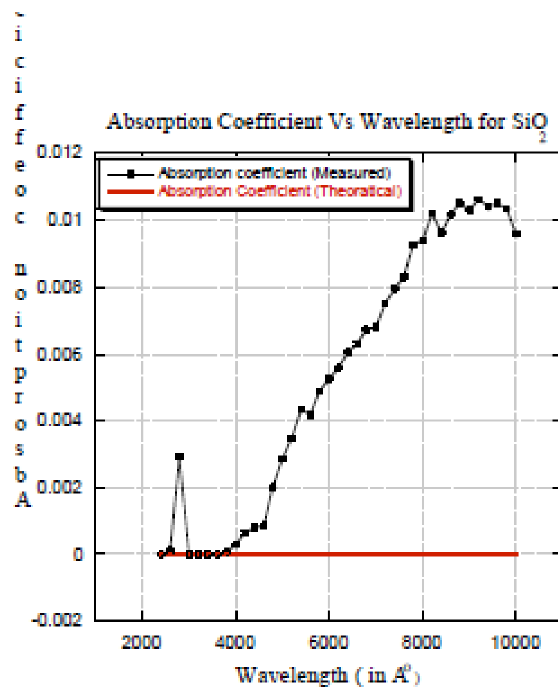

Figure 4. Silicon dioxide absorption coefficient. Comparison of PECVD and thermal oxide values.