Standard Operating Procedure (SOP)

Cambridge Nanotech S200 ALD

(ALD-01)

In case of fire or injury please call 911 (511 from Penn phones)

If there is an error on the system/tool please report it in IRIS, we will take care of it

Please *DO NOT* run diagnosis without a staff member's approval

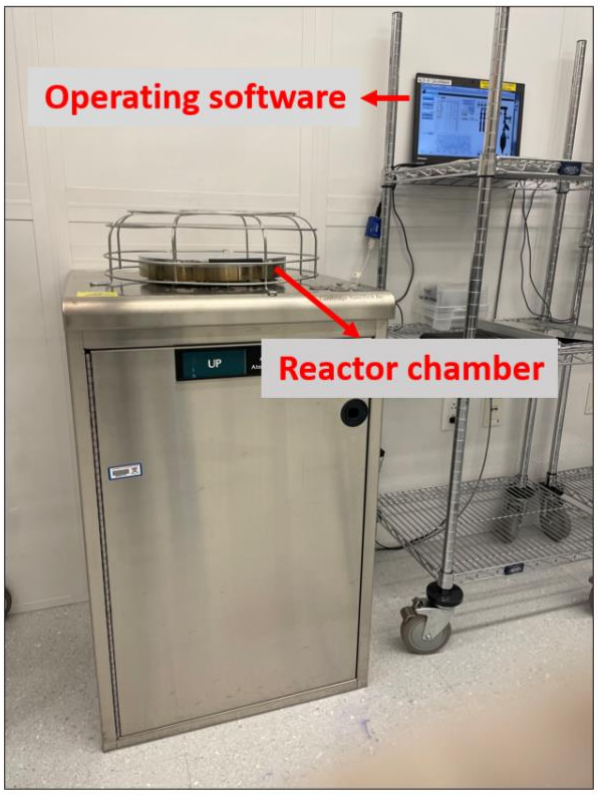
General safety tips and common mistakes

1) If the system is not running, make sure you are logged into the tool on IRIS.
2) If you are running a deposition at 250 °C, the heating of reactor may take up to 1 hour, please account for that time in your reservation. If you use 250C, make sure to set the temperature back to 150C.
3) The following materials are not allowed in the chamber:
   - *Any adhesive or plastic that can melt and attach to the inside of the reactor*
   - *Photoresist of any kind.*

   Contact the staff if you are using a material that is not listed here
4) **Caution!** The walls of the reactor are very hot!
5) **Attention!** If the pulse count alarm shows up report the issue on IRIS!
6) You can use the washers to lift your wafer for double side deposition.
7) Do not set the process temperature higher than 250 C without consulting with a staff member.

Last updated by Sam Azadi, 10/22/2021
Last reviewed by Sam Azadi, 10/22/2021

Cambridge Nanotech S200 ALD



- Primary tool owner: Sam Azadi.
  For questions regarding process development and characterization of film growth contact Sam Azadi at: azadi@seas.upenn.edu
  Problems with the tool ***MUST*** be reported on IRIS. Do not contact primary tool owner with tool issues directly.

Procedure Overview

1) Safety check
2) Vent the reactor
3) Load sample(s)
4) Pump the reactor
5) Choose/modify recipe and run deposition
6) Vent the reactor and retrieve wafer(s)/sample(s)
7) Pump the reactor

Tool Overview:

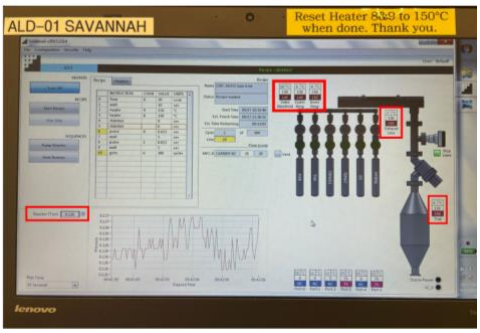
Cambridge NanoTech Savannah S200 ALD is an atomic layer deposition tool, equipped with precursors to deposit aluminum oxide, hafnium oxide, zirconium oxide, titanium oxide, and silicon oxide. Deposited films are amorphous.

Atomic layer deposition is a highly conformal process, meaning the thickness of the film on vertical walls is almost identical to that of angled surfaces. Any surface that the gas has access to will be covered with material, even high aspect ratio of 20:1.

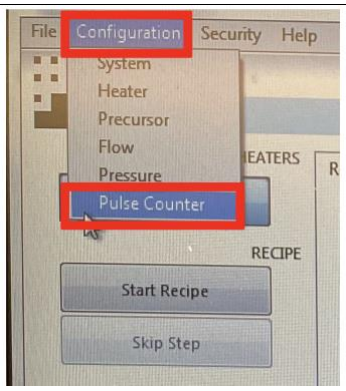
The deposition rate depends on the temperature of the reactor and increases with increase in that temperature. Alternating gases (precursors) are introduced into the chamber, the precursor dissociates and releases a ligand, the rest of the precursor molecules, including the desired material attaches to the surface, once there is no surface available, the binding stops, even if the tool is given more time. This makes the process self-limiting. In some cases, the precursor has poor attachment to the surface of the substrate and that may slow the beginning of the process. In case of depositing ALD on polymers, the precursor may defuse into the first few molecular layers of the polymer and initially slow down the growth of the thin film on top.

For more information about making a recipe and the ALD process please visit this *link*

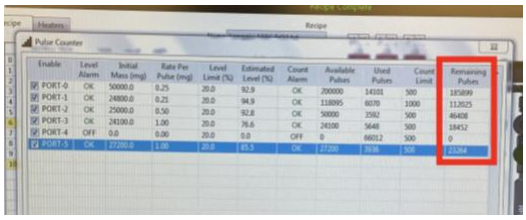
Full procedure:

Log into the tool via IRIS	
1. Safety Check: 1.1. Ensure no recipe is running. You can do so by checking the message displayed in the black text bar on top saying "*Pump Sequence Completed*" or if the "*Start Recipe*" button is active. The reactor pressure on the lower left side of the monitor should read ~ 0.13 Torr. 1.2. Ensure heaters 6, 7, 8, 9, and 10 are set and at 150 °C and read 150C. *Note:* *a) If the reactor was not pumped, report the issue on IRIS.*	

1.3. Make sure there is enough material left for your run. You can check by going to the top left of the screen. Click on "Configuration" and select "Pulse Counter".
The following popup appears. Check the right column for "Remaining Pulses".



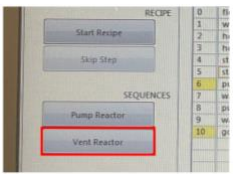
Note:
this cannot be done while a recipe is running.
You MUST check this before you start the recipe.

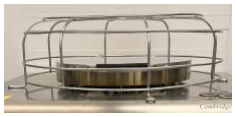


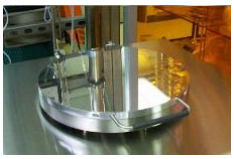
2. Vent the reactor:

2.1. Click on "**Vent Reactor**" button.
2.2. Allow the pressure to reach ~ 730 Torr.
2.3. Remove the large safety wire basket from the top of the reactor.

Caution! *The walls and lid of the reactor chamber are very hot!*

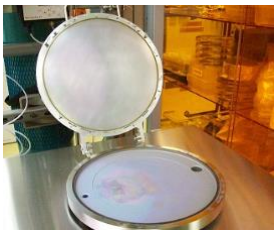






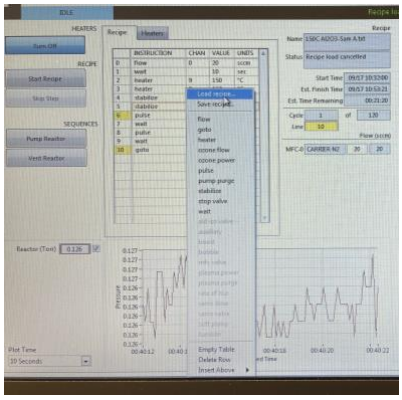
3. Load sample(s):

3.1. Open the lid and place your wafer(s)/sample(s) in the reactor.
3.2. Close the lid and place the safety wire basket on top of the reactor



Note:

a) You can use the washer next to the reactor to elevate your samples for ALD coverage on both sides of sample(s)/wafer(s)

4. Pump the reactor: 4.1. Click "**Stop Venting**" 4.2. Click "**Pump Reactor**" and allow the chamber pressure to reach ~ 130 mTorr and stay stable on that range.	
5. Choose/Modify Recipe and run deposition: 5.1. Right click on the recipe table and click "**Load Recipe**". 5.2. Pick your desired recipe 5.3. The only parameter to change in a recipe, is the number of cycles. This is done by changing the "**VALUE**" number in front of the line with instruction "**goto**" 5.4. Once the black text box reads "**recipe validated**" you can start the recipe by clicking on "**Start Recipe**"	
6. Vent reactor and retrieve samples/wafers ***Attention!*** If the pulse count alarm shows up report the issue on IRIS! 6.1. Once the black text bar reads "recipe completed" you may take your samples out 6.2. Click on "**Vent Reactor**" and allow the pressure to reach ~ 730 Torr and stabilize. 6.3. Take the safety basket off and open the lid, similar to step **2.** 6.4. Retrieve your samples and take washers out, if applicable. 6.5. Close the lid and place the safety wire basket on the lid.	
7. Pump the reactor: 7.1. Click "**Stop Venting**" 7.2. Click "**Pump Reactor**" and allow the chamber pressure to reach ~ 130 mTorr and stay stable on that range	
Log out of the tool via IRIS once the pumping is done	

Feel free to contact the staff members with any questions about your process and the tool.