ATOMIC LAYER DEPOSITION (ALD) SOP

BENEQ TFS-200

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Micro/Nano Technology Center

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See the staff first if the ALD is not turned on or if you need PEALD set up!

IMPORTANT INFO

Note: the ALD can be used in several modes:

1) Generic ALD using 2 or more reactive precursors that are sequentially delivered.
2) Plasma enhanced ALD. This is a "remote" configuration where the plasma is made and contained above the substrate so that there is no direct ion bombardment.
3) Ozone catalyzed ALD using the ozone generator. At the date of writing, we believe there is a problem with the ozone generator. We should invest in an in-situ ozone detector so that we can tune parameters to maximize ozone production.

Appropriate Substrates	Inappropriate Substrates
Silicon Quartz Aluminum Aluminum oxide	Polymers CMOS incompatible metals and materials: Au, Cu, Pt, etc.. Fine non-encapsulated particles

Start-Up

1. Log into your FOM account to turn on access to the ALD.

2. Login onto the computer and press the **LOGIN** button

   Login: **beneq** <enter>   Password: **beneq** <enter>

3. Go to the **ALARM** window and press **ALARM ACK** to clear the alarms**.**

4. Go to the **CONFIGURATION** window and press **DRY PUMP** to turn **ON** the pump.

5. Go to the **CONTROL** window and press **PUMPDOWN** and select **YES** when prompted to close the vacuum chamber door. This will pump down the main processing chamber.

6. If you know the recipe process temperature, from the **CONTROL** window set it in the **Reactor temperature** setting and click on the **Heating** button to start the chamber heating process.

Loading a substrate from the load lock (this is the default as of September 2022)

1. Make sure the load lock is pulled back to the load position by manually pulling the collar all the way to the right.

2. Go to the **LOAD LOCK window** and make sure the gate valve is closed by clicking on **GV CLOSE** and turning it green. If system is still initializing, this option may be greyed out while it pumps down or and an alarm may need to be acknowledged.

3. Press **LOAD LOCK VENT,** lift the red lever holding the door closed and continue by pressing **YES.** The load lock should be ready to open when the pressure reads ~1000 mbar and is in the **IDLE** state.

4. Open load lock door to load your **clean substrate** onto the substrate holder plate.

5. Close the load lock and red lever.

6. Click on **Load lock pump down** and press **YES** to continue.

7. Wait until prompted to open the gate valve and press **GV open**. It will turn it green and the gate valve will open.

8. Gently push the collar of the substrate holder into the processing chamber until you reach the stop. **NOTE:** The sliding collar has a star written on top of it.

9. Push and hold the **SUBSTRATE LIFTER** button on the right side of the tool to lift the substrate from the transfer arm.

10. Pull the collar out of the processing chamber to its home position.

11. Close the gate valve by pressing **GV close**.

12. Push the **SUBSTRATE LIFTER** button to lower the substrate into the holder lifter.

13. Push the **HOLDER LIFTER** button on the tool to lift the substrate into position for processing. Go to step 14, Running a Recipe to continue

Manually Loading the Processing Chamber without load lock (deprecated)

1. Go to the **CONTROL** window. If the set point of the reactor is correct, then press **HEATING** and it will turn green.

2. If using a hot source turn on **HEATING** in a similar manner for the selected Hot Source.

3. In the **CONTROL** window, select **VENT** to vent the processing chamber and to load a wafer or sample.

4. When vented the tool will say **IDLE** at the top part of the screen. Open the primary lid of the processing Chamber and manually remove the secondary lid using the lid holder.

5. Make sure the substrate chuck in the upper most position. If not depress **HOLDER LIFTER** on the tool.

6. Load your sample in the processing chamber.

7. Place the secondary lid on the processing chamber with the lid holder tool.

8. Press **PUMP DOWN** on the control window and press **YES** when prompted to close the chamber door.

Running a Recipe

14. Go to the **CONTROL** window and select your recipe from the drop-down box located above **RECIPE COMPILE AND DOWNLOAD.**

15. Click on **RECIPE COMPILE AND DOWNLOAD** to load the desired recipe into the tool's memory.

16. Click on **START BATCH** and **START BATCH** again in the pop-up box.

17. If any **HOT SOURCES** need to be heated, activate the **HEATING** button to allow the source to slowly reach temperature.

18. Note your recipe and operating parameters in the log book.

19. Most recipes will allow time for the **REACTOR** and any **HOT SOURCES** to reach their operating temperatures to ensure a steady temperature, press **YES** to continue once these have been achieved.

20. After a few minutes a pop-up window will request you to open any precursors necessary for the recipe, open the cabinet under the machine and turn only the **RIGHT** valve to open for the necessary precursors and click **YES** on the pop-up window.

21. The recipe will start and progress can be viewed by activating **LOOP COUNTER** on the **CONTROL** panel. If using the PEALD option, check that the reflected power is less than 10% of the forward power on the power supply or in the **Plasma** tab

22. When the recipe finishes it will request that you close any open precursors. Click **YES** to verify. **VERY IMPORTANT: Make sure the unheated precursor valves are closed as the system will pump and purge which could result in all the (expensive) precursors being pumped out of the bottle.**

23. Unloading your samples from the processing chamber can begin once the **IDLE** icon appears at the top of the screen.

Unloading Your Substrate and Shutdown through load lock

24. When the recipe is finished click or press **HOLDER LIFTER** to lower the substrate in the processing chamber.

25. Click or press **SUBSTRATE LIFTER** to raise the substrate in the processing chamber.

26. Go to the **LOAD lock** window and open the gate valve with **GV open***.*

27. Push the transfer arm collar into the processing chamber.

28. Click or press the **SUBSTRATE LIFTER** to lower the substrate onto the transfer arm.

29. Pull the transfer arm collar out of the processing chamber.

30. Go to the **Load lock** window and close the gate valve by clicking on **GV CLOSE** and turning it green.

31. Press **Load lock vent**, open the red lever on the load lock chamber door and continue by pressing **YES**.

32. Once the pressure says 1013 mbar or more open the load lock door. Remove your processed substrate from the substrate holder plate.

33. Close the red lever and load lock. Press **PUMP DOWN LOAD LOCK** and press **YES** in the window.

34. In the **Control** window turn **OFF** the heaters.

35. In the **Configuration** window turn **OFF** the **Dry pump** and then select **CLOSE USER INTERFACE**.

36. Logout of the Beneq software and shut down the laptop.

37. In the chase behind the ALD turn **OFF** the following utilities:

    a. Nitrogen N2 on the wall.

    b. Switch the Main Power handle to **"f"** on the control panel.

    c. Close both water lines to the roughing pump.

    d. Turn **OFF** the chiller rocker switch.

38. Logout of the tool in your FOM account.

Plasma Enhanced Depositions

Currently (March 2023), we can deposit Al_2O_3 and SiO_2 using the plasma enhanced mode of the reactor. This is a "remote" configuration where the plasma is made and contained above the substrate so that there is no direct ion bombardment.

General Guidelines for Recipes

Deposition Layer	First Precursor	Precursor 1 Temperature	2nd Precursor	Precursor 2 Temperature	Chamber Temperature	Deposition Rate (nm/pulse)
SiO2	TDMAS	Room Temperature	Oxygen Plasma	Room Temperature	200	**0.073**
SiO$_2$ (Deprecated but may still have precursor)	BDMS, Hot Source 1	30°C	Ozone or O$_2$ plasma?	Room Temperature	250°C	**0.027**
Al$_2$O$_3$	TMA, Precursor 2	Room Temperature	H$_2$O, Ozone, or O$_2$ plasma	Room Temperature	100-250°C	**0.22**
ZiO$_2$	DEZ	Room Temperature	H$_2$O	Room Temperature	250°C	**0.15**
TiO$_2$	TiCl$_4$	Room Temperature	H$_2$O	Room Temperature	100°C (amorphous)	**0.037**