

# Atomic Layer Deposition (ALD) Oxford FlexAL User Instructions

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## General Information

For problems, clarifications of procedures, or general information pertaining to this machine, please contact one of the following personnel.

<b>Mark Richmond</b>	<b>631-6478</b>	<a href="mailto:mrichmon@nd.edu">mrichmon@nd.edu</a>
<b>Dave Heemstra</b>	<b>631-6733</b>	<a href="mailto:dheemstr@nd.edu">dheemstr@nd.edu</a>
<b>Mike Thomas</b>	<b>631-7493</b>	<a href="mailto:mthomas8@nd.edu">mthomas8@nd.edu</a>

Currently available precursors in this machine can be used for the depositions of both dielectric films and metal films, which include Al<sub>2</sub>O<sub>3</sub>, SiN<sub>x</sub>, SiO<sub>2</sub>, HfO<sub>2</sub>, Pt, TiN, TiO<sub>2</sub>, and ZrO<sub>2</sub>.

All users wanting to reserve the machine for longer than 8 hour periods and/or more than 4 days a week are required to apply for user to [mrichmon@nd.edu](mailto:mrichmon@nd.edu) and include how long of reservations and how often you are planning to use the machine. If Mark is unavailable then contact [dheemstra@nd.edu](mailto:dheemstra@nd.edu) or [mthomas@nd.edu](mailto:mthomas@nd.edu), for approval. Once approval is received, send email to [oxfordald-pcs@anemone.nano.nd.edu](mailto:oxfordald-pcs@anemone.nano.nd.edu) with the information of your use and your contact information.

ICP Tube clean: Build-up of a conductive film, such as Pt and TiN, can impede the ICP power or even prevent the ignition of the plasma. Cleaning (ICP Tube Clean) is therefore mandatory. However, neither the O<sub>2</sub> nor SF<sub>6</sub> plasma is effective in cleaning the Pt film. Bead blasting cleaning (significant tool down time) of the ICP tube may be required.

**Only Clean wafers are allowed in the chamber. Pieces should be placed on the 6 inch plate. Deposition on Au is allowed up to 200 °C. Absolutely NO photoresist, tape, other metals, or plastics etc! If you are not sure whether your desired process is allowed or not, get approval!!**

**NO Photoresist**  
**NO Tape**  
**NO Plastics**  
**NO Thermal Grease**  
**NO Metals without explicit approval**  
**AU deposition only below 200-degree C**  
**No TiCl<sub>4</sub> use with water precursor**

\*A list of the standard (OPT) recipes is stored in the process library. These OPT recipes were calibrated to balance between the film qualities, the throughput, and to prolong the lifetime of the tool. Applying significant deviations to the parameters (ex. dose time, purge time, the temperatures) in these recipes is strongly discouraged.

All user recipes will start with their NETID.

## **Standby Conditions**

1. Table temp should be at 300-degree C
2. Overnight pumping will bring the base pressure down to  $e^{-6}$  Torr range.
3. The door for the precursor cabinet is closed and locked at all times.

## **Training procedure**

Contact Mark Richmond at [mrichmon@nd.edu](mailto:mrichmon@nd.edu) for instructions on how to get trained on this machine.

## **Start Procedure (Running a Deposition)**

1. Log into Coral and enable the machine. (Enables the 'Gas Pod' interlock)
2. Set the machine to your desired temperature.
3. Check your samples: clean? Yes. A carrier wafer should be used to load your sample. A conditioning run is also suggested on a dummy wafer before the real deposition process.
4. Go to Menu "System", click "Pump".
  - a. Go the bottom left of the page, click "Stop" and then "Vent". The loadlock chamber starts to vent and takes less than 5 minutes to reach the atmosphere.
  - b. Open the lid, and place your sample(s) on the wafer plate.
  - c. Close the lid and click "Stop" and then "Evacuate".
    - i. Enter wafer number or ID as appropriate.\
5. Go to Menu "Process" and click "Recipe". Depending on what film you wish to deposit, make your own recipe referring to those recipes with the name beginning with "OPT".
  - a. Select the type of process you desire to run, automatic or manual process. (Automatic is recommended for ease of use)
  - b. Select "Load" and find your recipe.
  - c. Once loaded, selct "Run" to start the recipe.
6. During the process, please check the process chamber condition and observe if the machine is following each step in the recipe.
7. When the process finishes, the sample will be automatically unloaded from the process chamber into the load lock chamber. A Yellow Alert will show "Process completed", click "OK" to dismiss.
8. Go to Menu "System", and click "Pump". Go to the bottom left of the page, and click "Stop" and "Vent". After 5 minutes, open the lid and take out the samples as well as the carrier wafer.
  - a. Close the lid, click "Stop" and then "Evacuate".
  - b. Enter "nw" for the wafer comment and click "OK".

9. If you have finished depositing a metal film (TiN or Pt), please run an ICP tube clean process.
10. Set the machine to the standby conditions.
11. In Coral, disable the machine and complete the Run Data Collector.

<b>Oxford demonstrated film rates in 2011</b>						
<b>Film @ 300°C</b>	<b>Cycles</b>	<b>Average Thickness(Å)</b>	<b>STD(Å)</b>	<b>n</b>	<b>k</b>	<b>GPC(Å/s)</b>
<b>TiN</b>	<b>400</b>	<b>144.582</b>	<b>2.3638</b>	<b>1.609</b>	<b>1.3764</b>	<b>0.361455</b>
<b>HfO<sub>2</sub></b>	<b>300</b>	<b>288.3</b>	<b>19.62928</b>	<b>1.9025</b>	<b>0</b>	<b>0.961</b>
<b>Si<sub>3</sub>N<sub>4</sub></b>	<b>500</b>	<b>142.088</b>	<b>2.31944</b>	<b>1.8216</b>	<b>0</b>	<b>0.284176</b>
<b>Al<sub>2</sub>O<sub>3</sub></b>	<b>206</b>	<b>215.254</b>	<b>0.2885</b>	<b>1.671</b>	<b>0</b>	<b>1.045</b>
<b>SiO<sub>2</sub></b>	<b>300</b>	<b>273.92</b>	<b>1.47078</b>	<b>1.4643</b>	<b>0</b>	<b>0.913067</b>

