CN1 Atomic Premium ALD

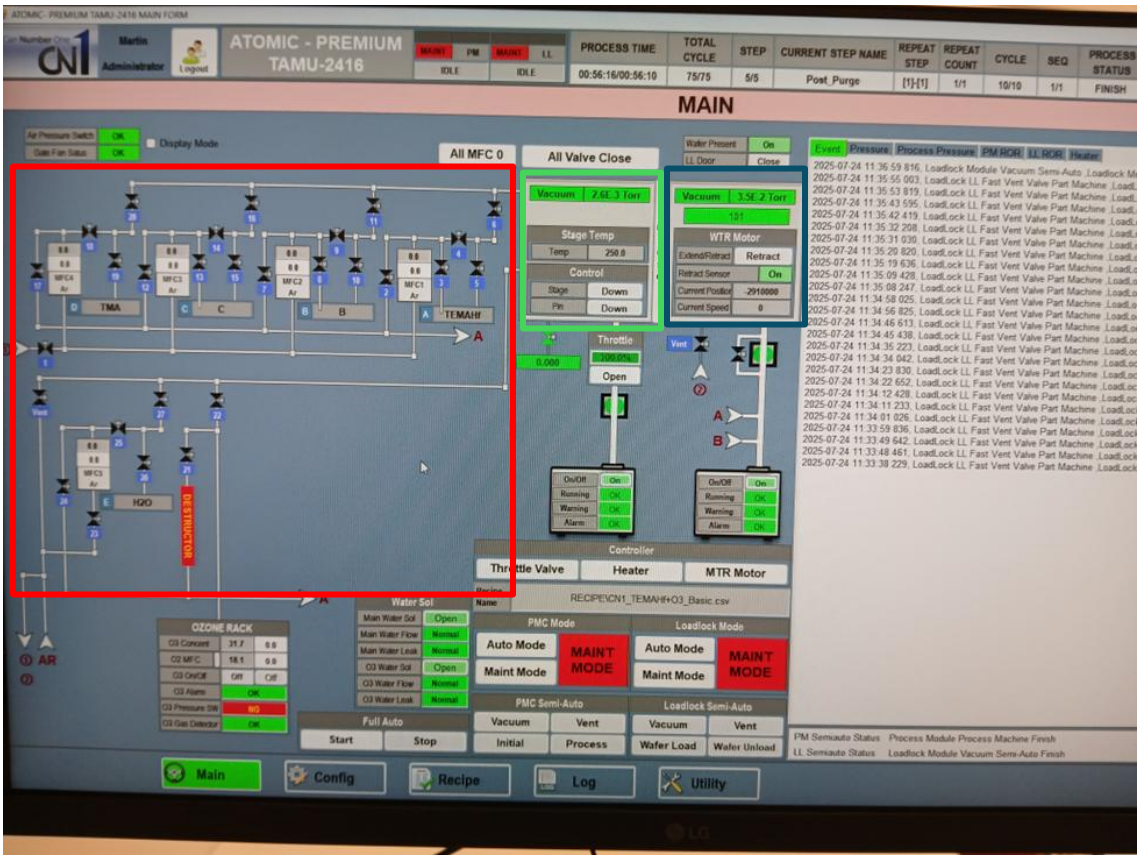
STANDARD OPERATING PROCEDURE

Username = Martin

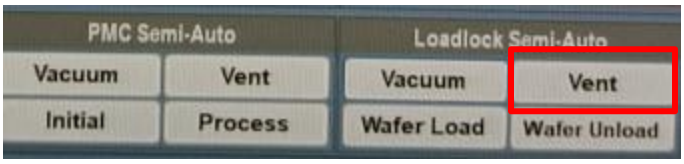
Password = 1

A. OPERATION

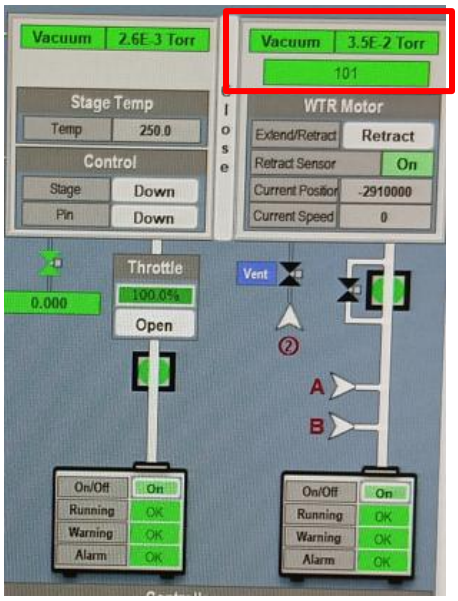
1. The MAIN page shows the GUI of the system with the **MFCs** and the **process chamber** and the **Loadloack**



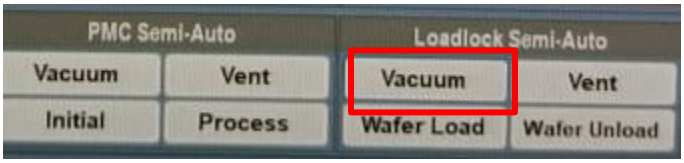
2. Vent the Loadlock by clicking the “Vent” icon



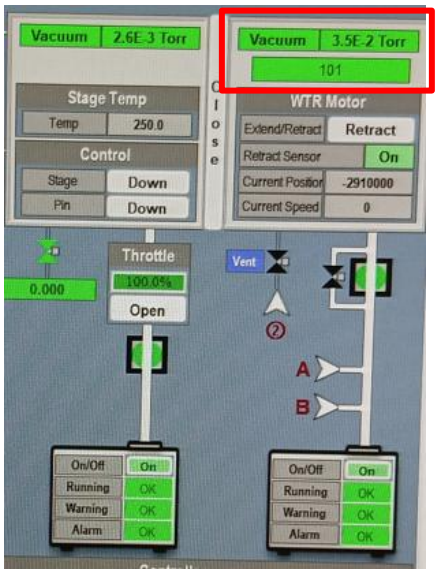
3. The Loadlock pressure will increase and change from “Vacuum” to “ATM” (atmosphere)



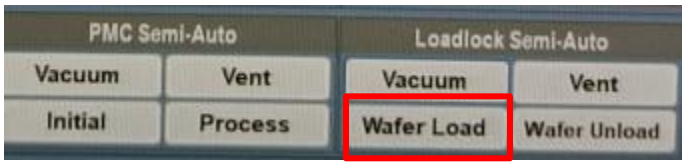
4. Open the Loadlock lid and place your sample. The 8” inch wafer can be used for carrier for coupon samples
5. After placing the sample close the Loadlock lid and click the “Vacuum” icon



6. The Loadlock pressure will drop and status will change to “Vacuum”

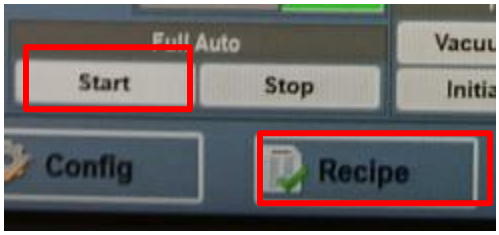


7. Select “Wafer Load” to load the wafer from the Loadlock to the process chamber

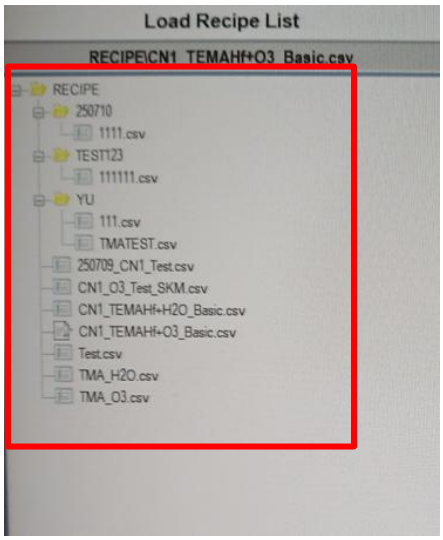


8. Select the Auto Mode before running the recipe and the **MAINT MODE** will change to **AUTO MODE**

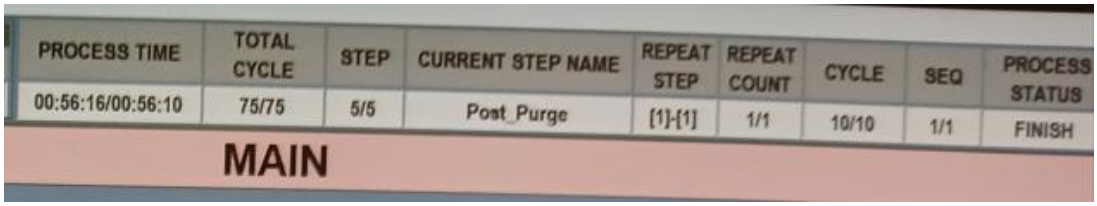
9. Select the “Start” icon under Full Auto and go to RECIPE



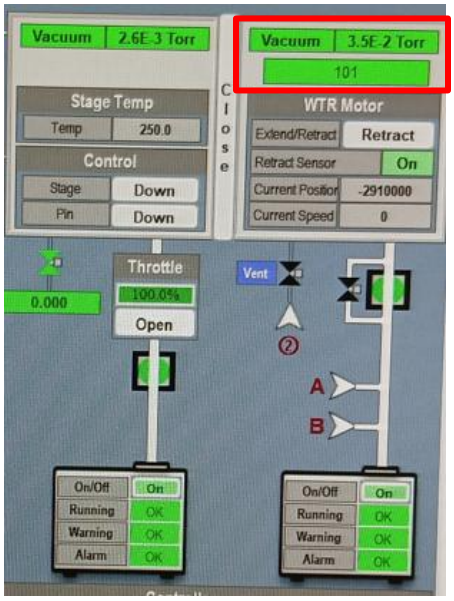
10. Select a recipe from the relevant folders and start the process under Full Auto Mode as selected in the previous step



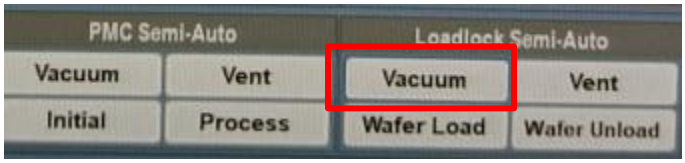
11. The no. of cycles, steps, current step name and process status will be displayed on top of the MAIN page



12. Once the recipe is complete the sample will be transferred from the process chamber to the Loadlock and the Loadlock will vent and the Loadlock pressure will increase and change from “Vacuum” to “ATM” (atmosphere)



13. Open the lid of the Loadlock and take the sample out and close the Loadlock lid and click the “Vacuum” icon



14. The Loadlock pressure will drop and it will pump down to vacuum

B. SIGNATURES AND REVISION HISTORY

a) Original author of this document: Prithvi Basu
b) Original author Title or Role: Research Engineer II
c) Date of original draft: 28 July 2025

Approval:

Senior Lab Manager Signature:

Date:

Revision	Author	Date
Original Issue	P.Basu	28 July 2025

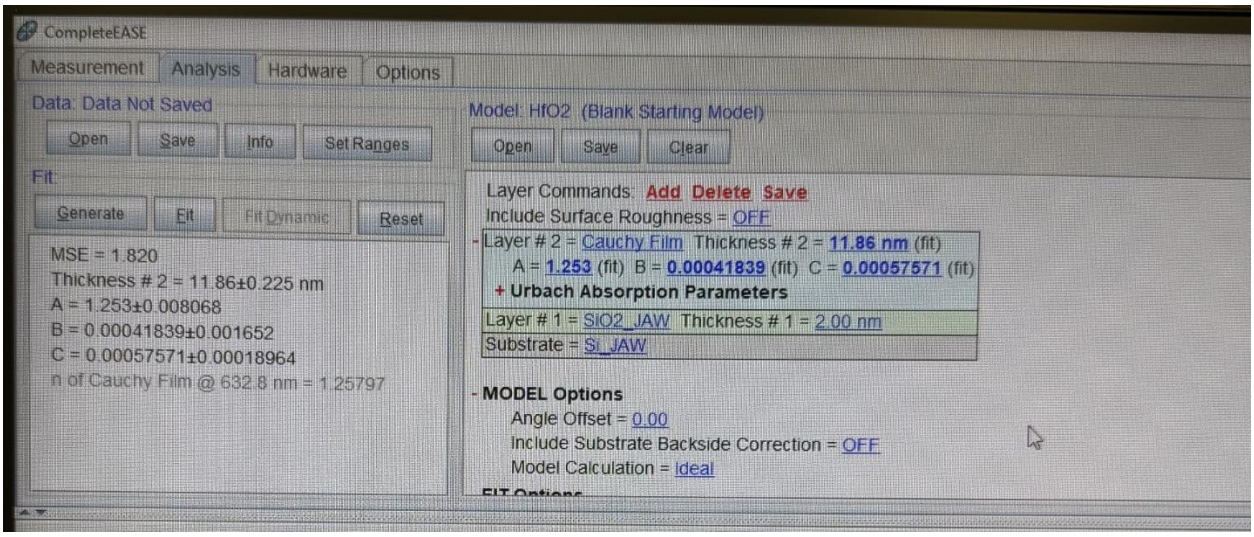
Appendix A

Please refer to the following procedure for measuring film thickness and refractive index using the ellipsometer.

1. Measurement Model

- For any type of film, use the Cauchy Film + SiO_2model.
- This model assumes a 2 nm native oxide layer and measures the Cauchy film deposited on top of it. Therefore, if the deposited film thickness is less than 2 nm, there is a high possibility of fitting errors due to the model limitation.
- Additionally, if the refractive index of the film does not appear properly and instead shows a value of 1.46 or lower, it indicates a measurement error. In such cases, the sample should be remeasured.

2. Fitting Procedure



If B > 0 and C > 0 → fitting is acceptable.
If B > 0 and C < 0 → set c = 0 and refit.
If B < 0 → first set C = 0 and refit.
If B is still negative, set B = 0.1 and refit again.

*MSE (Mean Squared Error) represents the difference between the measured ellipsometry data and the fitted model. A lower MSE value indicates a better fit between the data and the model, meaning the measurement error is smaller. Ideally, the MSE should be as close to zero as possible. In general, an MSE value below 3 is considered good. However, as the film thickness increases (above ~30 nm), it is possible for the MSE value to exceed 10, and this can still be considered normal.

3. Reason for Adjusting Negative Values

As the wavelength increases, the refractive index should physically decrease.
If a negative coefficient appears, it may result in an increasing refractive index with wavelength, which contradicts the physical behavior of thin films.
Therefore, negative values should be adjusted to zero(for C), 0.1(for B) to obtain physically meaningful and reliable fitting results.

Appendix B

1. For the plasma ALD make sure to enter/edit the value of the RF Power in the main recipe

Appendix C

1. Baseline recipe for HfO_2 with water in Thermal ALD:

   Baseline recipe name: **CN1_TEMAHf+H2O_Base gas**

Approx. average GPC center to edge across 8" substrate (Å/cycle) =0.85-0.95

Approx. average Refractive Index @ 632.8 nm center to edge across 8" substrate =1.85-2.0

Stage/Sidewall temperature (ºC)	Canister jacket/Canister line temp (ºC)	MFC1 (sccm)	MFC3 (sccm)	MFC4 (sccm)	MFC5 (sccm)	Source (sec)	Purge (sec)	Reactant (sec)	Purge (sec)
260/120	70/80	200	500	1000	1000	2	20	0.1	20

2. Baseline recipe for HfO_2 with ozone in Thermal ALD:

   Baseline recipe name: **CN1_TEMAHf+O3_Basic**

Approx. average GPC center to edge across 8" substrate (Å/cycle) =0.85-0.95

Approx. average Refractive Index @ 632.8 nm center to edge across 8" substrate =1.85-2.0

Stage/Sidewall temperature (ºC)	Canister jacket/Canister line temp (ºC)	Ozone Flow (sccm)	Ozone conc. (gm/m^3)	MFC1 (sccm)	MFC3 (sccm)	MFC4 (sccm)	MFC5 (sccm)	Source (sec)	Purge (sec)	Reactant (sec)	Purge (sec)
260/120	70/80	1000	220	200	500	1000	1000	2	20	5	20

3. Baseline recipe for Al_2O_3 with water in Thermal ALD:

Baseline recipe name: **CN1_TMA+H2O**

Approx. average GPC center to edge across 8" substrate (Å/cycle) =0.90-1.0

Approx. average Refractive Index @ 632.8 nm center to edge across 8" substrate =1.6-1.7

Stage/Sidewall temperature (ºC)	Canister jacket/Canister line temp (ºC)	MFC4 (sccm)	MFC5 (sccm)	Source (sec)	Purge (sec)	Reactant (sec)	Purge (sec)
260/120	Room temperature	500	500	0.2	10	0.1	10

4. Baseline recipe for Al_2O_3 with ozone in Thermal ALD:

Baseline recipe name: **CN1_TMA+O3**

Approx. average GPC center to edge across 8" substrate (Å/cycle) =0.85-0.95

Approx. average Refractive Index @ 632.8 nm center to edge across 8" substrate =1.5-1.7

Stage/Sidewall temperature (ºC)	Canister jacket/Canister line temp (ºC)	Ozone Flow (sccm)	Ozone conc. (gm/m^3)	MFC4 (sccm)	MFC5 (sccm)	Source (sec)	Purge (sec)	Reactant (sec)	Purge (sec)
260/120	Room temp.	1000	220	500	500	0.2	10	10	10

5. Baseline recipe for AlN with N_2/H_2 in Plasma ALD:

Baseline recipe name: **CN1_TMA_N2H2_Plasma**

Approx. average GPC center to edge across 8" substrate (Å/cycle) =1.0-1.1

Approx. average Refractive Index @ 632.8 nm center to edge across 8" substrate =1.9-2.0

Stage/Sidewall temperature (ºC)	Canister jacket/Canister line temp (ºC)	N_2/H_2 Flow (sccm)	RF Power (W)	MFC4 (sccm)	MFC5 (sccm)	Source (sec)	Purge (sec)	Reactant (sec)	Purge (sec)
260/120	Room temp.	2000	300	500	500	0.5	10	20	10