University of Minnesota Nano Fabrication Center
Standard Operating Procedure

Equipment Name: Woolam Spectroscopic Ellipsometer

Badger Name: ellipsometer-spectroscopic **Revision Number:** 3
Model: Woolam M-44 **Revisionist:** T. Whipple
Location: Bay 1 **Date:** 19 Mar 2020

1 **Description**
The Woolam M-44 is spectroscopic ellipsometer that uses a white light as a source.

2 **Safety**
a The system has no issues to have any safety concerns.

3 **Restrictions/Requirements**
a Must be a qualified user on the Spectroscopic Ellipsometer

4 **Required Facilities**
a Electrical power

5 **Definitions**
a Lamp housing LPS-300 unit
b Electronics control module EC-260 is the controlling electronic of the unit.

6 **Setup**
a Make sure the lamp has been on for 30 min before going to the next step, if off press POWER on lamp housing.

7 **Operating Instructions**
a The computer system that controls the software can be accessed by logging into the User account. Once there click on the icon on the screen called VASE32.

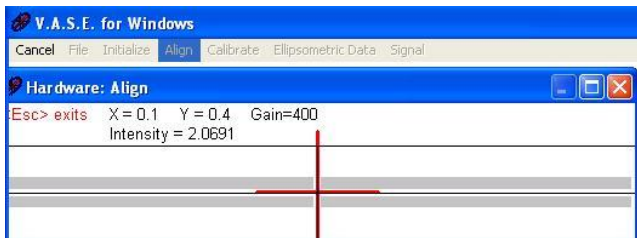
b Once the software is open, the whole screen might be the software, this is normal. Before you can measure your sample you will need to have the system calibrated. On the screen you will notice there are many windows, each one will be used for a given task. Windows names such as Hardware, model, Graph and others. Make sure that the Light Source is on. It is below the monitor/keyboard called LPS-300 and the Power and the Ignition both should lit. The main controller under this should also have the power button lite, labeled EC-260 on the front.

Opening screen displaying all the windows at once.

c First click on window labeled **<u>Hardware</u>**, then go to the top line of the main window and click on the item **<u>Initialize</u>**. Notice that clicking different windows will cause the options on the top line to change. The motors will start up shortly. Enter name of NFC or anything and press enter in the starting opening window.

d Align the light beam by placing the Thin Oxide setup sample, then from the **Hardware** window and click the **Align** item and then adjust the stage to move the RED + to be centered. Once it is in the center, press the Esc button.

e



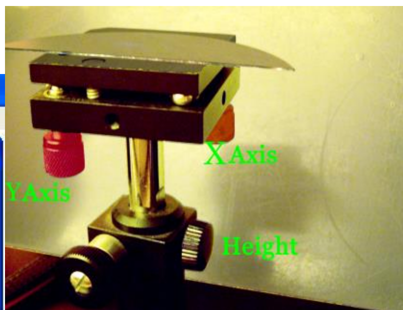
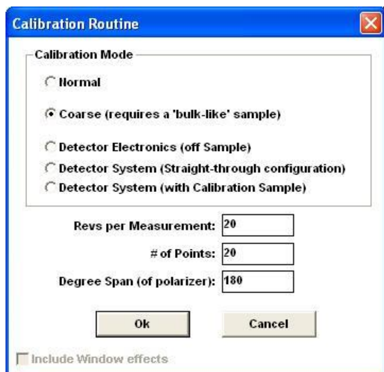


Image of alignment using a bare Si sample. Stage and adjustment knobs
CW increase CCW decreases

f Click on **Calibrate** and select **Course** (requires a 'bulk like' sample then click on the OK box to run it.) [ignore the box that pops up asking if you are sure you want to do course?] After the graph is updated run **Calibrate** and now select the **Normal** option. Set value to 100 Rev/measure to get greater accuracy. The graph will update each time.



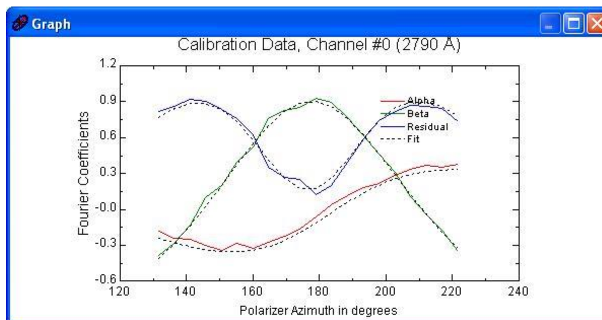
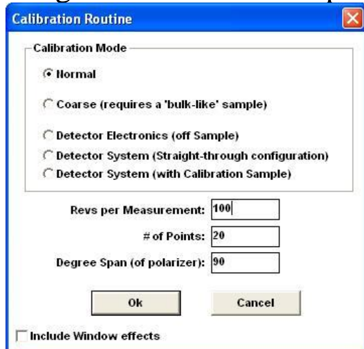


Image of the Course setup and the graph results



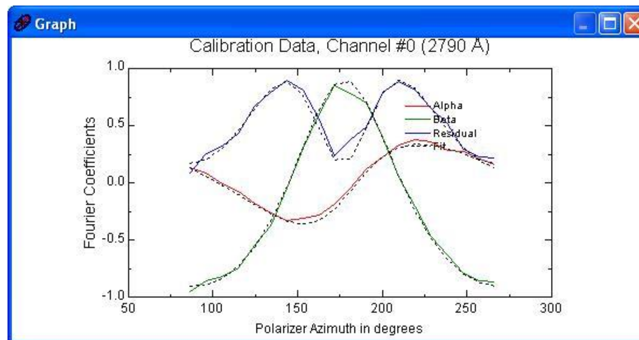
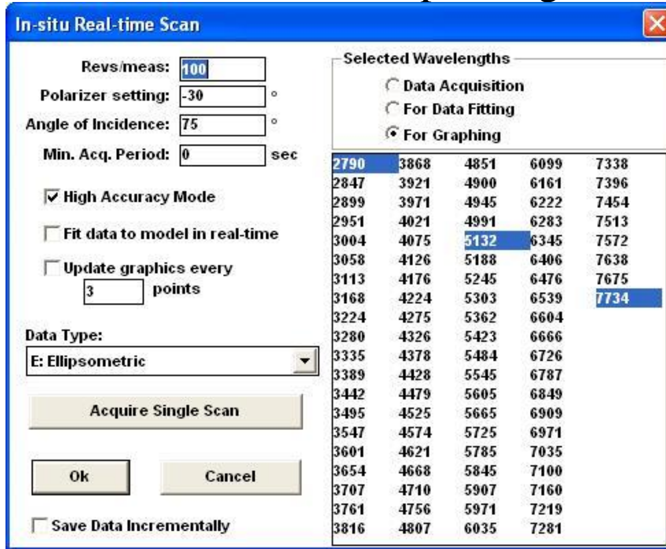


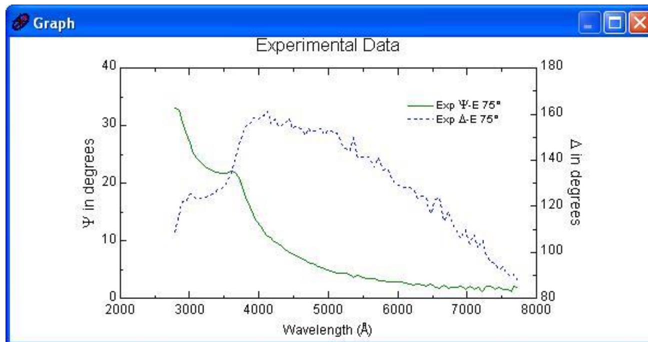
Image of the Normal setup options and graph – this takes 2:20 to get results.

g In **Hardware** window select option **Ellipsometric Data** option. Realtime scan window opens up.

h Select Higher Accuracy option and set **Rev meas:** to a value of 100 and then select the **Acquire Single Scan** box. A few seconds later a graph appears.



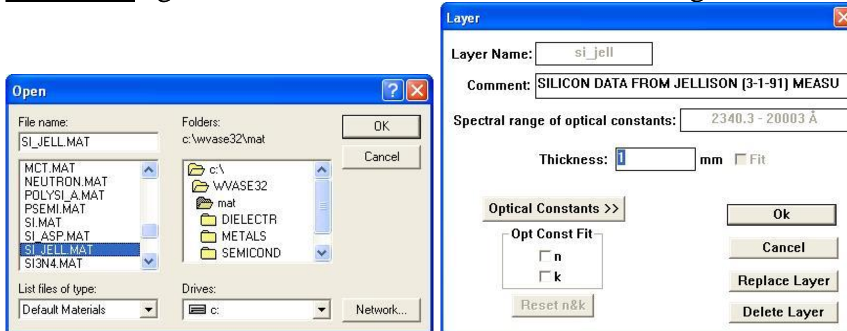
Realtime scan window click on the Acquire Single Scan box.



Graph that appears after the **acquire single scan** box is clicked.

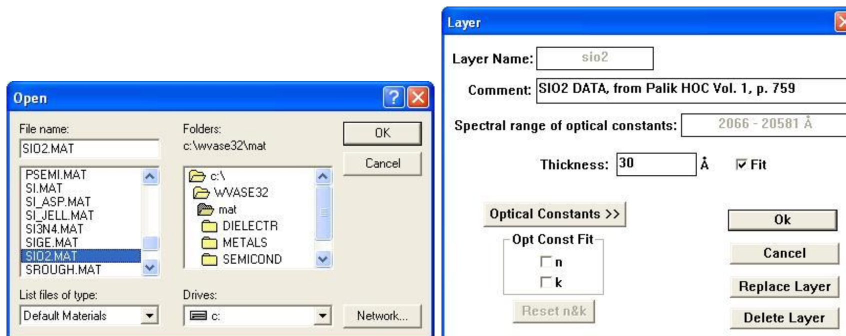
i If you made a mistake clicked on the **OK** box instead of the **acquire single scan** box the scan will run for a long time. Turn this off clicking the **Hardware** window and to the left of the **Ellipsometric Data** option is a **cancel** option, click that to stop it.

j Open **Model** window select **Add Layer** and select Si for the substrate, (***SI.MAT*** or ***SI_JELL.MAT***) for the substrate and for oxide select SiO2.mat) then click **add layer** again for SiO2 and set the thickness 30 Ang. Check the **Fit** box then



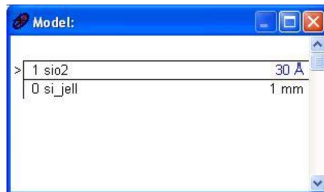
Selecting the first film the Silicon substrate, the 1 mm thickness is fine as is.

click OK box. Click **Generate Data** window. And then click on the **Generate Data** option from the top bar. A new graph image will be updated.



Selecting the SiO2 film that is on top of the bare wafer using 250 Ang thickness.

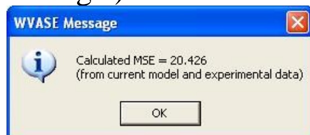
k In the MODEL window you can click on film line that you want to change, just click on it and make the changes you need to.



l Click on the Generated data window and then click on the **Generate Data** option. View the MSE value, the lower the value the better the fit between the model and measured values.

m Click the **Fit** window then click **Normal Fit** then the **MSE** window will appear. If you get an error stating Fit number Range make sure the Fit box was checked.

n The test “Change in MSE is Less than limit” is a good notice. The smaller the value the better the result. When the MSE is unity, the calculated data (on the average) lie within one standard deviation of the experimental data.



MSE window.

o Measuring the thin oxide can be done to confirm that system is working and should give a value around 250 Ang.

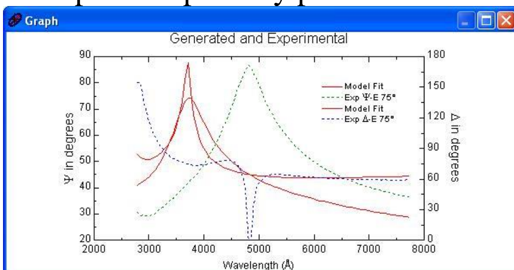
p Now remove the Thin Oxide setup sample and place your sample.

q Click the **Hardware** window and click the **Align** item and then adjust the stage to move the RED + to be centered. Once it is in the center, press the Esc button. During this time the display might be very slow updating, only make small adjustments and wait until the display updates before making any changes.

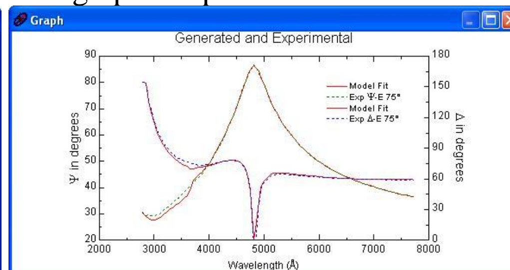
r In the **Hardware** window select the **Ellipsometric Data** option and then select the **acquire single scan** option.

s Select the film stack you want to measure by clicking the **Model** window and click on the top film click on **Replace Layer** box and select the film you want to measure. This can be done with the substrate too. If you have something other than Silicon material.

Measuring the film that you are interested in by setting the thickness of the film and clicking the **Fit** window then click on **Normal Fit** then the **FIT** option. Clicking on the option of point by point fit will cause the graph to update.



Graph after doing Normal fit



Graph after normal Point by Point fit

Wvl by Wvl Fit: Starting Parameter Values
Thick.1 806.5
Ok
Cancel
Starting Position
Shortest Wvl
Longest Wvl
Pts. to Ave. for next guess: 1.
Show Iterations

8 Problems/Troubleshooting:

On the computer desktop is folder which has the whole WVASE32 manual in it. Open it to find help while you are at the system. Contact NFC staff with questions.

9 Shutting down:

When you are done exit the VWASE. Leave the computer running. Contact NFC staff if you noticed anything that was not normal.