Chapter 6.55

Oxford Plasmalab System100 PECVD Chamber 4

Chamber Manual

(oxfordpecvd4) ***(586)***

1.0 Equipment Purpose

1.1 Oxfordpecvd4 is a capacitively coupled PECVD reactor that is capable of quickly depositing thin films onto 6-inch wafers at low temperatures. Pocket wafers are available that allow deposition onto 4-inch substrates and chips

1.2 This manual only describes available recipes, cleaning procedures and recipe creation for oxfordpecvd4 specifically. Oxfordpecvd4 shares controls with three other chambers in the same cluster, which are all their own tools (oxfordpecvd3, oxfordpvd2, oxfordpvd1). For information on operating this tool, refer to the common manual for this tool cluster; ***read the common manual before reading this document or proceeding with using this tool***

1.3 This chamber is held at a lower standard of cleanliness than its counterpart in oxfordpecvd3 but it has many more gases available, allowing for a greater variety of films to be grown in oxfordpecvd4

2.0 Material Controls & Compatibility

2.1 Pocket wafers for chamber 4 may not be used in chamber 3.

2.2 This tool accepts Si, Ge and III-V materials in addition to most metals (including refractory metals and most noble metals including Au and Ag). If there is doubt, please contact staff.

2.3 Since this tool runs samples with Au, Cu, and other known potential contaminants for active electronic devices, members with band-gap sensitive samples should review their process with process staff to best avoid process contamination.

2.4 No polymers of any kind are allowed in this chamber (e.g., no photoresist or kapton tape)

2.5 **No “temperature dot” measurement stickers.** (These evaporate when heated under vacuum and contaminate the chamber heavily

2.6 Substrates with vapor pressures above 1E-10 Torr at 350C may not be used in this system. (If you cannot find vapor pressure data, assume any material that reaches a boiling point at atmospheric pressure under 2000C cannot enter the tool - this is commonly available on wikipedia for many materials)

2.7 Low temperature oxide, PECVD oxide, and low stress nitride are allowed, but must first be dehydrated just prior to being processed (1 minute on a 350° C hotplate, or oven for at least 1 hour).

3.0 Training Procedure & Applicable Documents

3.1 Exam Tool - each tool in the cluster has its own online exam that must be completed before qualification. Timeline (estimated time to completion: 1 week)

3.1.1 Get trained by any qualified member.

3.1.2 Take the online test in the Nanolab office (open 8A-12P, 1P-5P).

3.1.3 Arrange a qualification session with a superuser to show competency on the tool.

3.2 Applicable documents:

3.2.1 Oxford Plasmalab System100 manufacturer's manual (412 pps.)

3.2.2 6.54 / 6.55 Oxford Thin-Film Deposition Cluster: the common manual for this tool cluster that describes procedures common to all four chambers

3.2.3 PECVD Overview for Oxford Instruments: a slideshow provided by Oxford Instruments to give an overview of the PECVD process

3.2.4 6.3 Oxfordpecvd4 SiOx Deposition: a document that contains information on the design of SiOx recipes in oxfordpecvd4, highlights the limitations of the tool, and contains film data on various recipes that were attempted as a part of the investigation

3.2.5 6.4 Oxfordpecvd4 SixNy Deposition: the same content as the above document, but has information on ***ammonialess*** SixNy recipes in oxfordpecvd4

4.0 Definitions & Process Terminology

4.1 Chamber clean: a process that uses CF_4/N_2O to vaporize film that deposits onto the chamber walls during the deposition, followed by pure N2O to remove any carbon residues that deposits from the CF_4 cleaning step

5.0 Safety

5.1 The same safety rules apply for this tool as for the tool cluster. Refer to the common manual for safety rules common to all chambers in the cluster

5.2 The system will automatically abort your recipe if the reflected power is too high, but in the time that it takes for the system to automatically abort, the power supply can sustain damage. It is therefore necessary to actively monitor the forward power

5.2.1 If the reflected power is more than 5% of the forward power or more than 10W (whichever is higher), abort the recipe by clicking [JUMP] within the [Process] → [Chamber X] window to skip the current step and advance to the pump/purge steps of your recipe

5.3 If the capacitors are at too high or too low values for extended periods of time, it can result in damages to the RF automatch network including shorted capacitors which can bring down the tool several months as a new capacitor is being ordered

5.3.1 If either capacitor setpoint is above 80% or below 20%, abort the recipe by clicking [JUMP] within the [Process] → [Chamber X] window to skip the current step and advance to the pump/purge steps of your recipe and consult the process engineer for this tool on what can be done to your recipe to bring the capacitors into more safe operating regimes

5.4 Use of the LF generator is currently being curtailed; the LF generator panel is not communicating properly with the software, so the software registers extraordinarily high reflected power despite the actual reflected power as read off the generator panel on the tool itself being at stable values. LF usage requires staff training and approval.

6.0 Process Data

6.1 Tool monitors have not been set up for this tool; monitors will soon be set up for the following recipes:

6.1.1 CH4 - STD - SiOx Recipe 1010

6.1.2 CH4 - STD - SixNy Recipe 2010

6.2 To see the recipe run history that includes the recipes that were run and the length of time each recipe was run for, users can look at the [Log View] for this tool, which is found in the [Process] dropdown menu

7.0 Available Processes, Gases, Materials. Process Notes

7.1 There are three generators available on oxfordpecvd4:

7.1.1 81 MHz 500 Watt: this is known as the **VHF** generator. It is used for most of the new standard recipes for this tool and is the recommended generator for this tool. **Do not exceed 400 W without engineer approval**

7.1.2 13.56 MHz 300 Watt: this is known as the **HF** generator. It is used for the old standard recipes for this tool

7.1.3 50 kHz – 460 kHz 500 Watt: this is known as the **LF** generator. It is currently only used for a few cleaning recipes but can be used upon consultation with the process engineer for this tool. See the note in the “safety” section of this manual for the current soft prohibition on this generator

7.2 Available gasses, with flow limits for each associated MFC:

7.2.1 N_2O: 1000 sccm

7.2.2 Ar: 1000 sccm

7.2.3 CF_4: 500 sccm

7.2.4 N_2: 2000 sccm

7.2.5 CH_4: 100 sccm

7.2.6 H_2: 200 sccm

7.2.7 NH_3: 50 sccm

7.2.8 SiH_4 (10% solution in Ar): 50 sccm

~~**7.2.9** PH_3 (1% solution in H_2): 200 sccm~~

7.2.10 TMB (10% in H_2): 200 sccm

7.3 Soft limits on other process variables for this tool:

7.3.1 Pressure: 1200 mTorr, though 1000 mTorr is optimal. At higher pressures the plasma begins to flicker due to overwhelming of the APC, causing poor deposition quality. It is good practice not to go below 600 mT, since low pressures can stress the RF matching network which might result in permanent damage to the matching capacitors

7.3.1.1 Processes above 1000 mTorr require staff oversight for development.

7.3.2 Total flow rate: max 1500 sccm. It is recommended to stay at or below 1100 sccm since the APC tends to fail to stabilize the chamber pressure at higher flow rates. The gas inlet tube becomes overwhelmed at high flow rates and begins to destabilize and the APC cannot adjust fast enough to regulate flow.

7.3.3 Temperature: max 350°C. The tool can go to 400°C, but it is best not to exceed 350°C

7.3.4 Depositions exceeding 2 um require staff approval

7.4 **Available Processes**:

7.4.1 CH4 - STD - Fast Clean 350C (standard clean process for most recipes)

7.4.1.1 Etch rates of the [81 MHz Etch] step for various materials. This step is the only step that etches away material during chamber cleans; the LF step only sputters away the hard contaminants and the Carbon Scourge step only getters carbon that deposits from the CF_4 in the [81 MHz Etch] step

7.4.1.1.1 SiO_x: 83 nm/min

7.4.1.1.2 Si_xN_y: 36 nm/min

7.4.1.1.3 a-Si: ~240 nm/min

7.4.1.1.4 SiC_x: 16 nm/min

7.4.1.1.5 SiO_xN_y: TBD

7.4.1.1.6 *Etch rates are frequently updated to reflect current tool conditions*

7.4.2 CH4 - STD - SiOx Recipe 1010 (near-stoichiometric fast oxide)

7.4.2.1 Ar: 650 sccm, N_2O: 150 sccm, N_2: 200 sccm, 10% SiH_4/Ar: 50 sccm

7.4.2.2 Generator: 81 MHz, Power: 200 W

7.4.2.3 Pressure: 1000 mTorr, Temperature: 350C

7.4.2.4 Deposition Rate: 171 nm/min, Non-Uniformity: 1.8%

7.4.2.5 Refractive Index: 1.468, Film stress: -280 MPa

7.4.3 CH4 - STD - SiOx Recipe 1007 (Si-rich fast oxide)

7.4.3.1 Ar: 750 sccm, N_2O: 50 sccm, N_2: 200 sccm, 10% SiH_4/Ar: 50 sccm

7.4.3.2 Generator: 81 MHz, Power: 200 W

7.4.3.3 Pressure: 1000 mTorr, Temperature: 350C

7.4.3.4 Deposition Rate: 169 nm/min, Non-Uniformity: 1.8%

7.4.3.5 Refractive Index: 1.492, Film stress: -120 MPa

7.4.4 CH4 - STD - SixNy Recipe 2010 (near-stoichiometric fast nitride)

7.4.4.1 Ar: 150 sccm, N_2: 800 sccm sccm, 10% SiH_4/Ar: 50 sccm

7.4.4.2 Generator: 81 MHz, Power: 300 W

7.4.4.3 Pressure: 1000 mTorr, Temperature: 350C

7.4.4.4 Deposition Rate: 101 nm/min, Non-Uniformity: 2.0%

7.4.4.5 Refractive Index: 1.962, Film stress: -220 MPa

7.4.5 CH4 - STD - SixNy Recipe 2004 (Si-rich fast nitride)

7.4.5.1 Ar: 450 sccm, N_2: 500 sccm, 10% SiH_4/Ar: 50 sccm

7.4.5.2 Generator: 81 MHz, Power: 200 W

7.4.5.3 Pressure: 800 mTorr, Temperature: 350C

7.4.5.4 Deposition Rate: 84 nm/min, Non-Uniformity: 2.1%

7.4.5.5 Refractive Index: 2.602, Film Stress: -40 MPa

7.4.6 CH4 - STD - SixNy Recipe 2101 (near-stoichiometric nitride grown with ammonia)

7.4.6.1 NH_3: 21 sccm, N_2: 1000 sccm, 10% SiH_4/Ar: 35 sccm

7.4.6.2 Generator: 13.56 MHz, Power: 20 W

7.4.6.3 Pressure: 650 mTorr, Temperature: 350C

7.4.6.4 Deposition Rate: 114 Å/min, Non-Uniformity: 0.8%

7.4.6.5 Refractive Index: 2.01

7.4.7 CH4 - STD - aSi Recipe 3101 (standard undoped amorphous silicon)

7.4.7.1 H_2: 25 sccm, 10% SiH_4/Ar: 25 sccm

7.4.7.2 Generator: 13.56 MHz, Power: 20 W

7.4.7.3 Pressure: 600 mTorr, Temperature: 350C

7.4.7.4 Deposition Rate: 4.5 nm/min, Non-Uniformity: 0.1%

7.4.7.5 Refractive Index: 4.12

7.4.8 CH4 - STD - SiC Recipe 4001 (standard silicon carbide using Ar)

7.4.8.1 CH_4: 12 sccm, 10% SiH_4/Ar: 40 sccm, Ar: 748 sccm

7.4.8.2 Generator: 81 MHz, Power: 200 W

7.4.8.3 Pressure: 1400 mTorr, Temperature: 350C

7.4.8.4 Deposition Rate: 85 nm/min

7.4.8.5 Refractive Index: 2.2

7.4.9 CH4 - STD - SiC Recipe 4002 (standard silicon carbide using Ar)

7.4.9.1 CH_4: 12 sccm, 10% SiH_4/Ar: 40 sccm, Ar: 568 sccm, H_2: 180 sccm

7.4.9.2 Generator: 81 MHz, Power: 200 W

7.4.9.3 Pressure: 1400 mTorr, Temperature: 350C

7.4.9.4 Deposition Rate: 68 nm/min

7.4.9.5 Refractive Index: 3.06

7.4.10 CH4 - STD - SiC Recipe 4101 (standard silicon carbide using 13.56 MHz)

7.4.10.1 CH_4: 60 sccm, 10% SiH_4/Ar: 7.5 sccm

7.4.10.2 Generator: 13.56 MHz, Power: 200 W

7.4.10.3 Pressure: 1400 mTorr, Temperature: 350C

7.4.10.4 Deposition Rate: 10.7 nm/min, Non-Uniformity: 2.2%

7.4.10.5 Refractive Index: 2.25

7.4.11 If any of the above recipes are missing from the recipe list, or if you suspect that a standard recipe has been mistakenly altered by another lab member, report a yellow fault and the engineer for this tool will look through the process logs to recover the lost recipe

7.4.12 Other recipes available for general use: these are recipes that can be found in the “Guide to SiOx/SixNy Deposition” documents found in the applicable documents section of this report

Other Available SiO_x Deposition Recipes					
	Typical Film Properties				
Recipe Name & Description	Dep. Rate (Å/min)	Dep. Rate non-Uniformity (%)	Refractive Index (at 633 nm)	Stress (MPa)	Density (g/cm^3)
CH4 - STD - SiOx Recipe 1001	858	2.7	1.465	-380.0	1.99
CH4 - STD - SiOx Recipe 1002	876	2.0	1.481	-190.0	2.00
CH4 - STD - SiOx Recipe 1004	1745	1.6	1.468	-300.0	2.13
CH4 - STD - SiOx Recipe 1005	883	2.4	1.466	-360.0	2.05
CH4 - STD - SiOx Recipe 1006	1312	2.3	1.466	-330.0	2.06
CH4 - STD - SiOx Recipe 1008	1316	2.2	1.466	-360.0	2.08
CH4 - STD - SiOx Recipe 1009	1276	2.0	1.490	-140.0	2.05

Other Available Si_xN_y Deposition Recipes					
	Typical Film Properties				
Recipe Name & Description	Dep. Rate (Å/min)	Dep. Rate non-Uniformity (%)	Refractive Index (at 633 nm)	Stress (MPa)	Density (g/cm^3)
CH4 - STD - SixNy Recipe 2001	975	1.4	2.200	-90.0	2.23
CH4 - STD - SixNy Recipe 2002	488	4.8	2.398	0.0	1.83

CH4 - STD - SixNy Recipe 2003	492	3.4	2.334	30.0	2.02
CH4 - STD - SixNy Recipe 2005	887	2.1	2.324	-110.0	2.18
CH4 - STD - SixNy Recipe 2006	934	3.6	2.326	-60.0	2.03
CH4 - STD - SixNy Recipe 2008	969	3.6	2.096	-210.0	2.34
CH4 - STD - SixNy Recipe 2009	968	3.6	2.130	-120.0	2.20

8.0 Equipment Operation

8.1 REMEMBER TO CONSULT THE COMMON MANUAL FOR GUIDELINES ON RUNNING A RECIPE BEFORE PROCEEDING HERE

8.2 Performing a Thin-Film Deposition in Oxfordpecvd4

8.2.1 The following recipes must be run **for each wafer** you process, in this sequence:

8.2.1.1 [Step 1] Chamber clean (optional): depending on the cleanliness you desire out of your deposition, it is wise to run a clean recipe before depositing any film. The length of this clean is left up to the discretion of the lab member and this clean may be skipped. Performing this clean can also help with minimizing run-to-run variability

8.2.1.1.1 Use CH4 - STD - Fast Clean 350C as your cleaning recipe, and use the Fast Clean recipe that is at the same temperature as your deposition recipe

8.2.1.2 [Step 2] Chamber season/condition:

8.2.1.2.1 Oxfordpecvd4 has a wide variety of films it serves. The film previously deposited in the chamber can cause a high run-to-run variability in deposition quality. To minimize this variability, lab members need to run seasoning wafers to condition the chamber with their film before running their device wafers

8.2.1.2.2 To run a seasoning recipe, use the same deposition recipe as you will be using on your device wafer

8.2.1.2.3 Run this recipe for at least 140 nm of deposition or for 6 minutes, whichever is shorter. Lab members can increase their seasoning times to obtain higher standards for wafer repeatability if they so choose

8.2.1.2.4 Record the capacitor setpoints midway through this seasoning recipe and enter them into your deposition recipe for use as initial capacitor setpoints if you have not done so for your deposition recipe already; this will make your plasma ignite almost instantaneously during your deposition

8.2.1.3 Step 3 Deposition on your wafer

8.2.1.4 Step 4 Chamber clean:

8.2.1.4.1 Use CH4 - STD - Fast Clean 350C as your cleaning recipe, and use the Fast Clean recipe that is at the same temperature as your deposition recipe

8.2.1.4.2 To determine the cleaning time for your recipe, add up all the depositions you performed (i.e., seasoning thickness + device wafer thickness) and use the etch rate of your material using Fast Clean to determine the time to etch away all of the material, adding a 20% over-etch (e.g., for a 140 nm seasoning + 500 nm SiO_2 device wafer, the etch time would be (140 nm + 500 nm)*(1.20)/(83 nm/min) = 9.25 minutes)

8.2.1.4.3 Consult the "available processes" section of this manual for information on etch rates for each material

8.2.2 Lab members wishing to deposit unique materials must determine the etch rate of that material themselves in order to determine the amount of time needed for chamber cleans

8.2.2.1 Etch rates are determined as follows:

8.2.2.1.1 Deposit an ample amount of film onto a bare Si wafer (usually 200-500 nm is enough) and measure the average thickness of the film on the wafer. Do not run a chamber clean to make sure the chamber is maximally loaded with material to clean off for the subsequent step

8.2.2.1.2 Run the Fast Clean recipe on your sample for a known amount of time and aim to remove at least 50% of the film. After this is done, you may finish cleaning the chamber. Measure the average thickness of the film after this etch

8.2.2.1.3 The etch rate is the difference between pre- and post-etch thicknesses divided by the time of the [81 MHz Etch] Step (this is the only step that etches material from the chamber)

8.2.3 Each recipe (including the chamber cleans and seasons) **must** be run with a wafer present in the chamber; running a recipe without a wafer risks dirtying the wafer platen and damaging the lifting pins

8.2.3.1 Chamber clean recipes can be run with a bare Si wafer, and bare Si wafers can be reused up to 25 times for cleaning recipes before a new Si wafer should be used

8.2.3.2 Seasoning recipes can be run on a dedicated wafer that can be reused across depositions. Each material should use its own seasoning wafer (e.g., a dedicated seasoning wafer for SiOx, a dedicated seasoning wafer for SixNy, etc.), and a new seasoning wafer should be used after 4 microns of seasoning deposition

8.3 Creating a New Recipe in Oxfordpecvd4

8.3.1 When making a new recipe in oxfordpecvd4, it is recommended to use the following recipe template: **CH4 - STD - Recipe Template**. This template has all the pre-heat, ramp and pump/purge steps necessary for a deposition

8.3.2 This template can be loaded and edited to suit your desired deposition

8.3.3 Do NOT overwrite this recipe template. Report a yellow fault if this recipe template is missing from the recipe list

CH4 - STD - Recipe Template		
Step #	Title	Description and Purpose
1	`Wafer Pre-Heat`	1-minute of wafer pre-heating while inert gas flows This step is necessary because there is poor thermal contact between the table heater and the wafer, so it takes about a minute to heat up the wafer to the desired temperature. This step also flows an inert gas (usually N_2) to help purge the gas lines of any contaminants before process gases are allowed to flow
2	`Gas Ramp`	Flowing process gases with no power for 30 seconds This step ensures that the inert gas from the wafer pre-heat step has been flushed out of the chamber and helps to give a smooth ignition when the generator power is turned on. This step flows process gases at the same pressure and flowrates as the deposition recipe to follow
3	`Deposition`	Flowing process gases with power This is where you load your recipe parameters. Recipe parameters can be found via experimentation or by looking through scientific literature to find deposition recipes on similar PECVD/PVD tools
4	`Timed Pump - 1000 mT`	Flowing an inert gas while stepping down in increments of 250 mTorr and 250 sccm of inert gas for 15 seconds at each step These "timed pump" steps serve to flush the process gases out of the chamber while incrementally decreasing the chamber pressure in a way that does not put too much stress on the pump. The first step takes place at 1000 mT while flowing 1000 sccm of N_2 and subsequent steps step down from that
5	`Timed Pump - 750 mT`	
6	`Timed Pump - 500 mT`	
7	`Timed Pump - 250 mT`	
8	`Timed Pump - 0 mT`	Flowing no gas while pumping down to 0 mTorr for 30 s This step has the same purpose as the other timed pump steps, but flows no inert gas
9	`Pump to Base`	Pumping down to base pressure

	Pressure	Whereas the above step pumps down to 0 mTorr and holds it at that pressure for 30 seconds, this step simply pumps to base pressure to allow the system to remove the wafer from the chamber

8.3.4 Additional pump/purge steps (e.g., a series of pump/purge steps following the wafer preheat step to purge the wafer pre-heat gases from the chamber) may be added at the lab member's discretion, but this series of steps work for the majority of processes on the tool

8.4 Editing a Recipe in Oxfordpecvd4

8.4.1 This section has notes on aspects of recipe editing *unique* to oxfordpecvd4. For all other aspects of recipe editing that are common to the other tools in this cluster, see the common manual

8.4.2 Generator Selection:

8.4.2.1 To use either the HF or LF generator, the select the [13 MHz] box under the [RF GENERATOR SELECTION] tab

8.4.2.2 To use VHF generator, the select the [81 MHz] box under the [RF GENERATOR SELECTION] tab

8.4.2.3 The column labeled [LF GENERATOR] corresponds to the 50 kHz – 460 kHz generator, the column labeled [RF GENERATOR] corresponds to the 13.56 MHz generator, and the column labeled [VHF GENERATOR] corresponds to the 81 MHz generator

8.4.2.4 The LF and HF generators are capable of operating on a pulsed basis, where one generator will run for a set amount of time before the other generator is turned on for another set amount of time

8.4.2.4.1 To turn on this option, select [PULSED] for both the LF and HF generators and enter in your desired pulse time and forward power for each generator

8.4.2.4.2 *Due to safety issues with the LF generator, this pulsed option is not recommended to be used until further notice*

9.0 __Troubleshooting Guidelines__

9.1 Problem: The recipe never starts and the APC never stabilizes

9.1.1 Cause of the Problem: Total flowrate is too high and the APC cannot open far enough to compensate

9.1.2 Solution: Try lowering the total flowrate of the recipe; this is typically done by decreasing the ballast gas flow rate

9.2 Problem: The plasma is not striking, and the reflected power is abnormally high before the recipe suddenly aborts

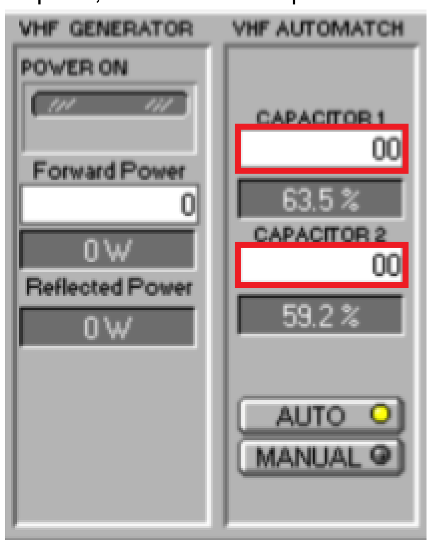
9.2.1 Cause of the Problem: Either the pressure is too high, or the power is too low for the given process conditions

9.2.2 Solution: Try either decreasing the pressure in increments of 100 mTorr or increasing the power in increments of 25 W. Take caution when exceeding 300 W, and do not exceed 400 W

9.3 Problem: The plasma takes a long time (more than 5-10 seconds) to strike

9.3.1 Solution: Wait for the plasma to ignite, and record the capacitor setpoints in the "RF GENERATOR SELECTION" box. When the recipe is finished, go back into the recipe editor and enter those capacitor values into the "CAPACITOR 1" and "CAPACITOR 2" fields. The next time the deposition recipe is run, the capacitors will start at those values and settle into their equilibrium positions in a shorter amount of time, yielding a faster ignition

9.3.2 Capacitor 1 is the tuning capacitor and capacitor 2 is the load capacitor. To get the fastest ignition, it is best to set the tuning capacitor to be slightly lower than its setpoint, and the load capacitor to be slightly higher than its setpoint



9.3.3 This solution is particularly effective for the 81 MHz generator and yields nearly-instantaneous ignitions. The 13.56 MHz generator takes longer for its capacitors to settle into their setpoints, so this method is less effective for that generator. It is recommended to use the capacitor setpoints as of 5-10 seconds following the formation of a stable plasma when using the 13.56 MHz generator instead of using the steady-state capacitor setpoints

9.4 Problem: The plasma is not striking, but the APC stabilizes and process gases are flowing

9.4.1 Solution: This is a somewhat uncommon problem that occurs in some recipes. If the plasma does not ignite while process gases flow, it will not yield any film and might damage the RF automatch network. If this happens, try tweaking your process parameters and contact staff for advice if necessary

10.0 Study Guide

10.1 How high is an acceptable reflected power on this tool?

10.2 You notice that one of the standard recipes has been modified by another lab member. What should you do?

10.3 For the RF automatch network, what values of the load and tune capacitors are cause for worry for the system? What should be done if during your recipe, you observe these capacitor values?

10.4 Is it permissible to make a recipe that uses the LF generator?

10.5 You notice that a cleaning recipe uses the LF generator. Is this cause for concern?

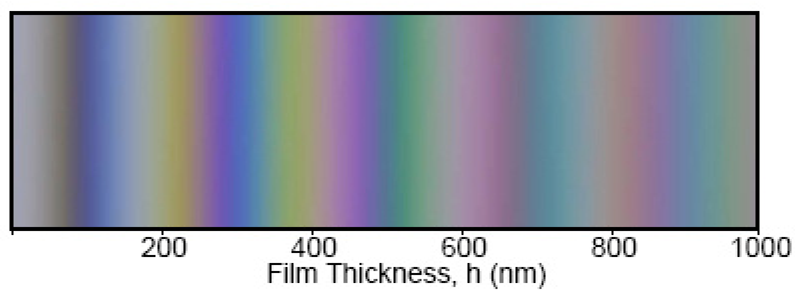
10.6 What is the name of the cleaning recipe that you should use to clean up most films in oxfordpecvd4?

10.7 Give an example calculation for how to determine the cleaning time of your chamber.

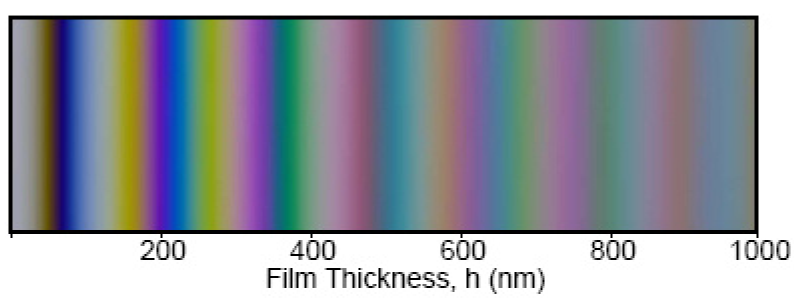
11.0 ***Appendices, Figures & Schematics***

11.1 Oxide film thickness chart for assessing film thickness with the unaided eye, from: https://opg.optica.org/oe/fulltext.cfm?uri=oe-12-7-1464&id=79472

Apparent color of a stoichiometric SiO_2 film on silicon as a function of thickness:



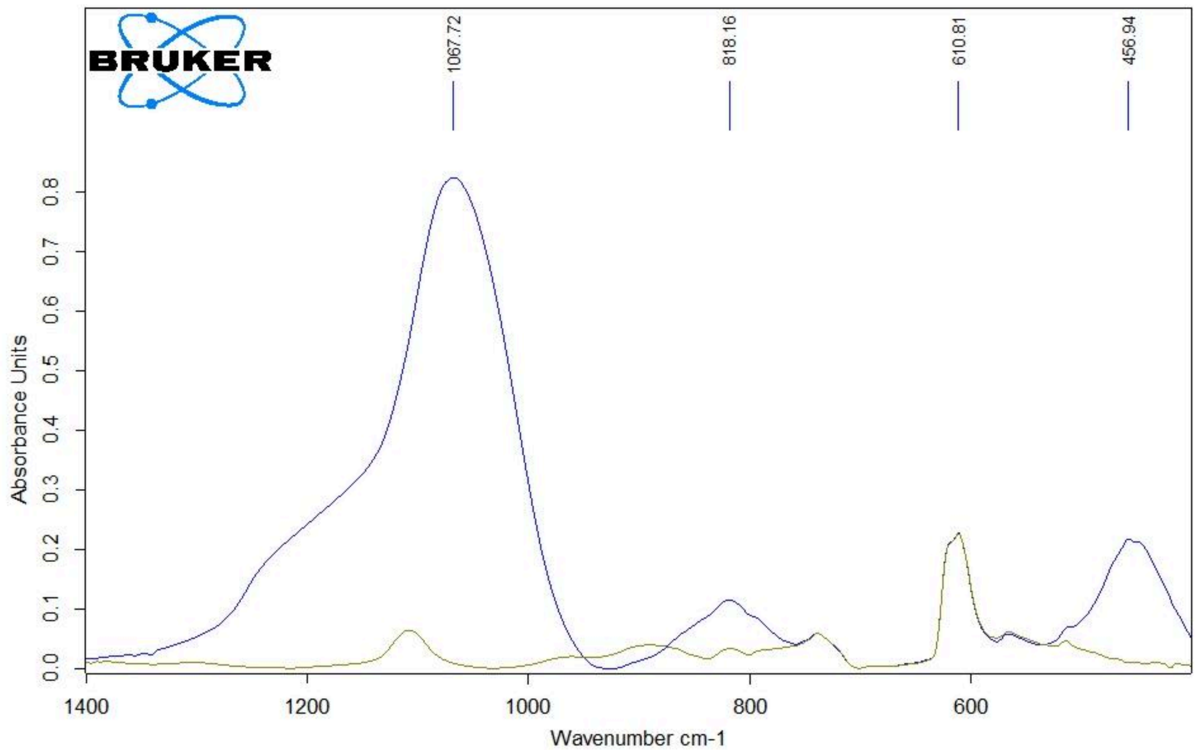
Apparent color of a stoichiometric Si_3N_4 film on silicon as a function of thickness:



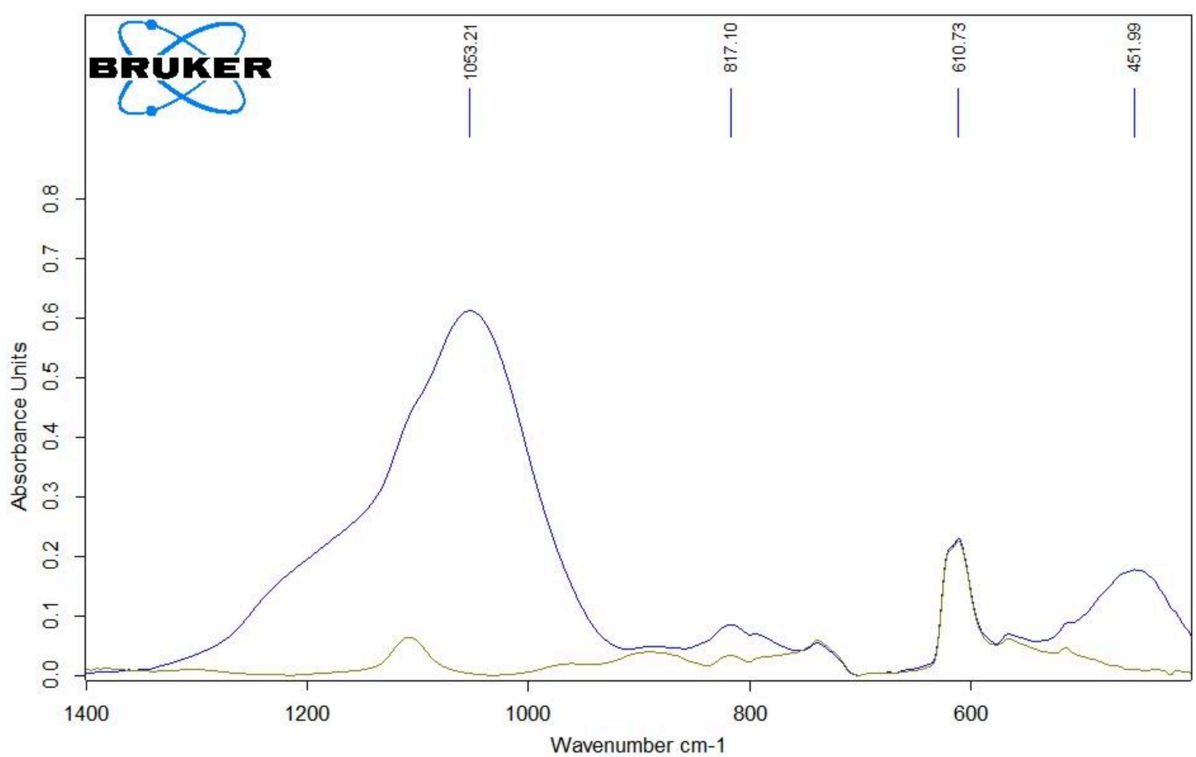
11.2 FTIR spectra of some commonly-made films are shown as follows:

11.2.1 For the SiOx spectra below, the blue line indicates the spectrum of the film + the wafer, and the yellow line represents the spectrum of the wafer itself

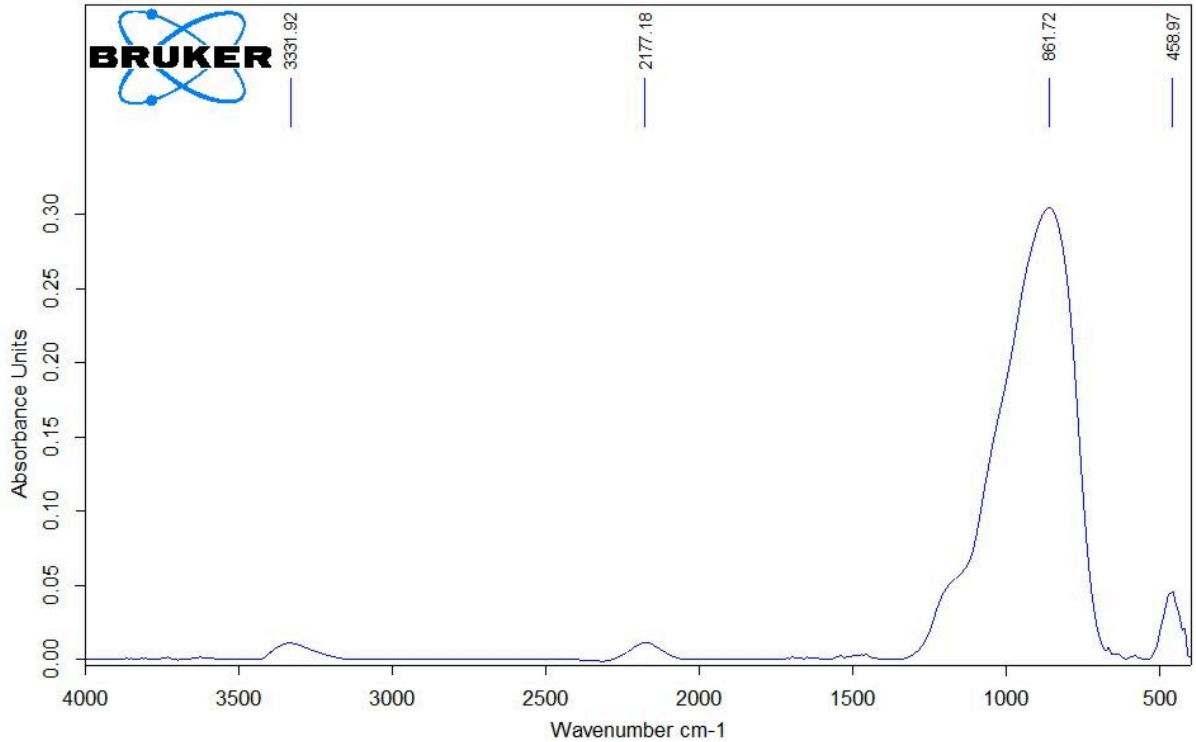
11.2.2 The FTIR spectra of the SixNy films were taken using Si wafers as the background measurement instead of taking a pure air background measurement



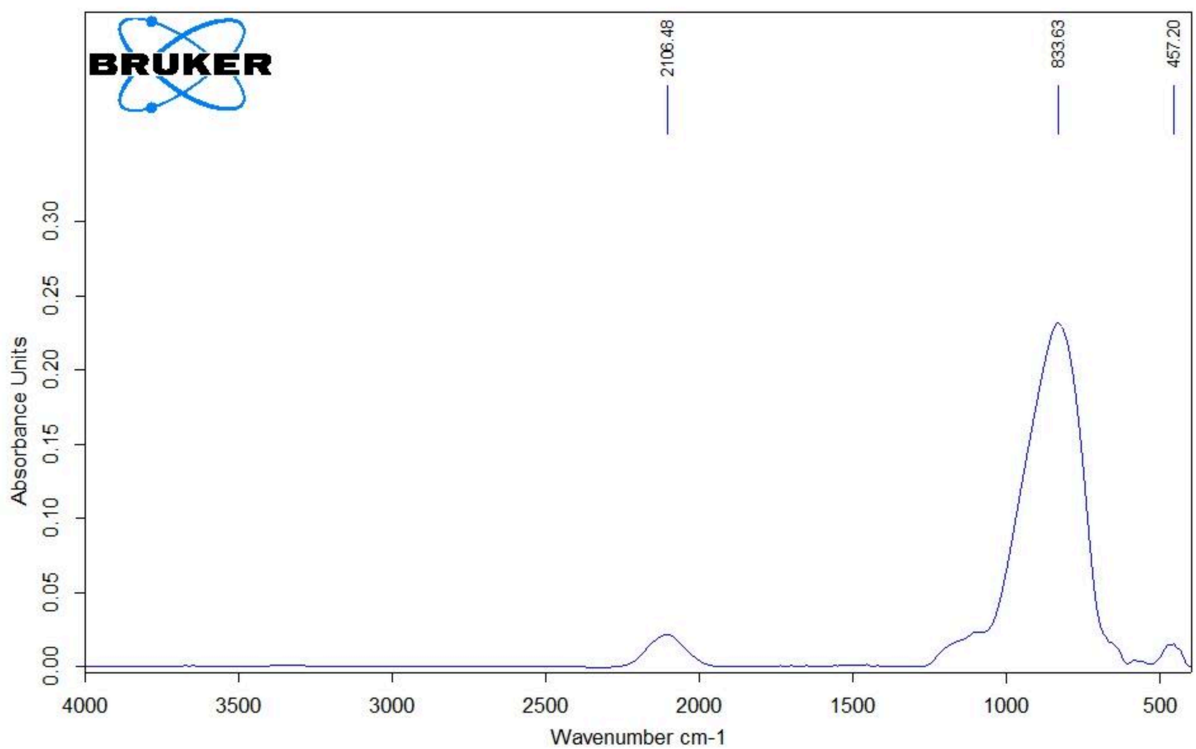
868 nm-thick SiOx film grown using CH4 - STD - SiOx Recipe 1010.
Peak FWHM = 118.7, peak intensity = 0.825



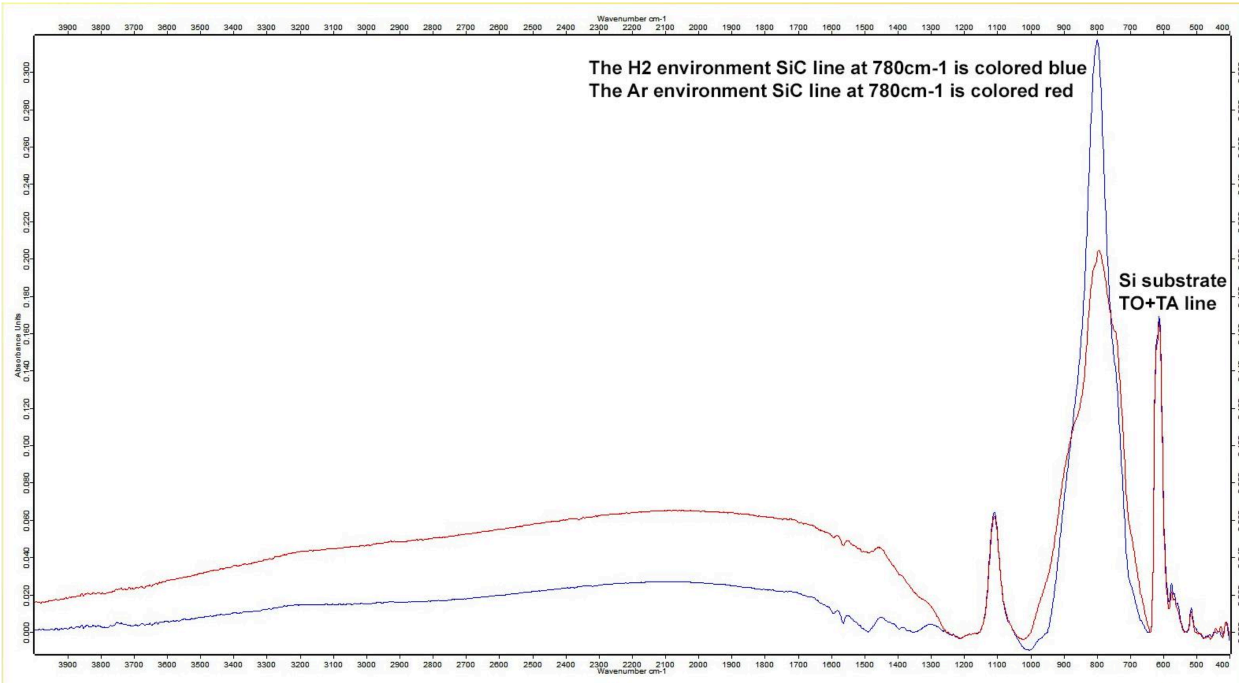
844 nm-thick SiOx film grown using CH4 - STD - SiOx Recipe 1007.
Peak FWHM = 145.0, peak intensity = 0.612



453 nm-thick SixNy film grown using CH4 - STD - SixNy Recipe 2010



639 nm-thick SixNy film grown using CH4 - STD - SixNy Recipe 2004



This spectrum shows the relative amount of Si-C bonds as determined by the FTIR 780cm-1 Si-C stretching mode after a 5 minute 1050°C anneal in the Tystar3 furnace for CH4 - STD - SiC Recipe 4002 and CH4 - STD - SiC Recipe 4001