University of Minnesota Nano Fabrication Center
Standard Operating Procedure

Equipment Name: Ion Mill

Coral Name:	ionmill	**Revision Number:**	5
Model:	Intlvac	**Revisionist**:	Kevin Roberts
Location:	Bay 3	**Date:**	12/22/2021

1 Description

The Intlvac Ion Mill is used for non-chemical etching of thin films. To accomplish this, the chamber is first pumped down to low pressure and then back filled with Argon gas. The Argon is then ionized and accelerated by an electric field toward the substrate. This kinetically energized Ar "sputters" or removes the film from the substrate (**see Figure 1**).

Figure 1 - The Intlvac Nanoquest Ion Mill Etching System:

2 Safety

a

3 Restrictions/Requirements

a Must be a qualified user on the Ion Mill.

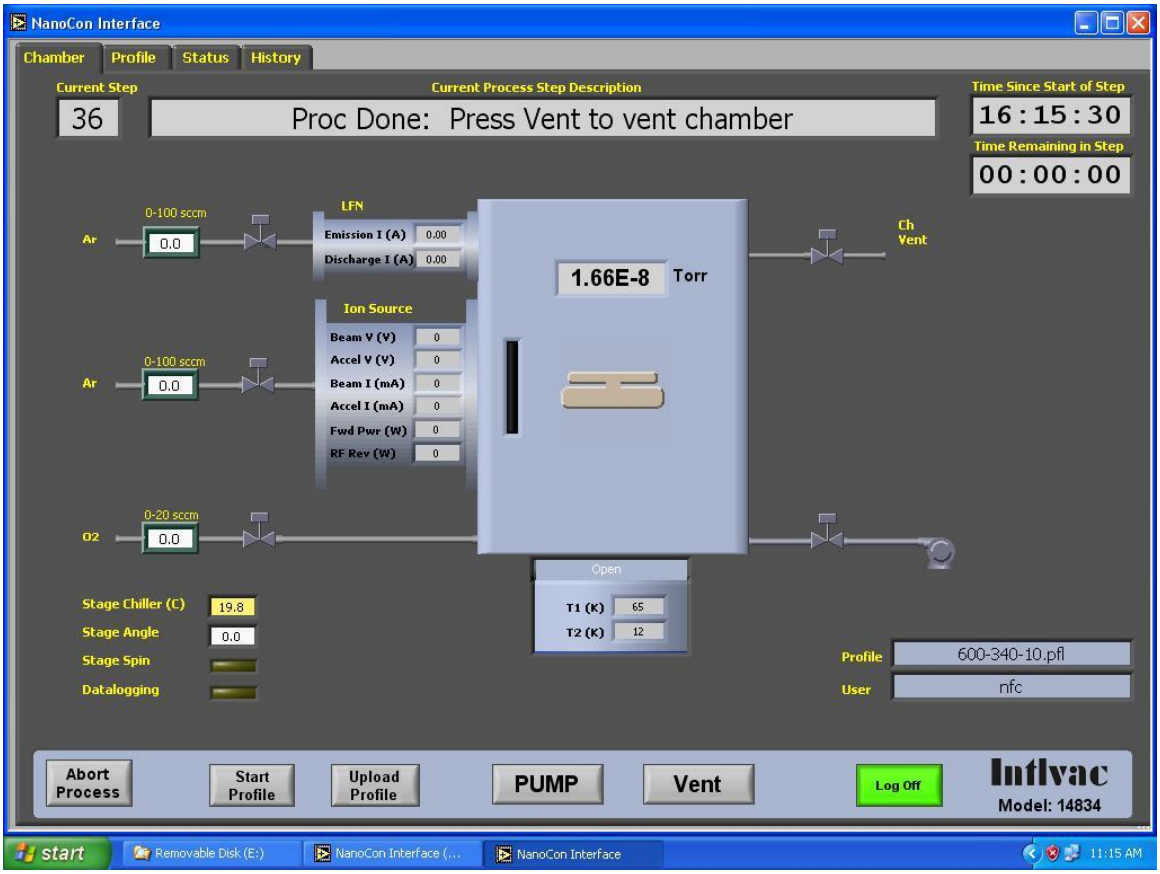
4 Required Facilities

a Compressed air
b Argon
c Nitrogen
d Chilled water

5 Definitions

a Ion Beam Current – The amount of ions being accelerated toward the substrate.

Chamber Tab Screen Shot:



Profile Tab Screen Shot:

6 Operating Instructions

a ENABLING / LOGGING IN

1 Make sure latch on chamber door is in down position before proceeding, or you may experience errors in the software when you try to vent.

2 Enable 'ionmill' in Badger.

3 Go to **Chamber Tab** on screen.

4 Click on **Log On** icon.

5 Login with user name: nfc password: 1234

b CHAMBER VENTING:

1 Press VENT on **Chamber Tab**. (hold icon down for several seconds to activate).

If you forgot to move the latch down at the beginning and get a Vent Error, move latch down, and click Vent icon again to reinitiate vent cycle.

2 Press **Process Advance** button when prompted.

c SAMPLE LOADING:

1 Open door.

2 Remove metal retaining ring.

3 Set wafer on silver impregnated pad.

4 Press **Process Advance** physical button (turns on dry vacuum pump in chase)

5 Hook up vacuum tube, and flip up toggle switch for stage vacuum. Allow to pump for 5 minutes. No more, no less.

6 Replace metal retaining ring (do not over tighten).

7 Flip stage vacuum toggle back down and disconnect tube from stage.

8 Press **Process Advance** physical button.

10 Close door.

11 Press **Process Advance** physical button.

12 Push latch on door in vertical upward position, but slightly biased so it will fall forward once pump down begins (i.e move latch so computer display shows "door open' going away when correctly positioned). *Latch being positioned vertically initiates the pump down sequence.*

If latch does not fall down, move to down position for the sake of future process steps and avoiding venting errors.

d PUMP DOWN:

1 System will cross over to high vacuum (i.e open cryo) at 2.00E-1 Torr, or 200 mTorr.

2 System is ready to run a Profile (i.e a recipe) at 5.00E-6 Torr.

e START YOUR RUN

1 Go to **Profile Tab** on screen.

2 Click on **Open…** icon on screen.

3 Choose profile you wish to work with: slow or fast. Users can change process time or stage angle (75 degrees is default) if they want to, but should leave other parameters alone. Note: Users logged in as the 'nfc' user cannot save recipes.

4 Click **Upload** icon to upload profile to microcontrollers of system.

5 Go to **Chamber Tab**.

6 Click on **Start Profile.** Stage will cool from 20C to 6C which will take 10 minutes. Then, process will begin.

f UNLOADING SAMPLE

1 Make sure latch on chamber door is in down position before proceeding, or you may experience errors in the software when you try to vent.

2 Click on **Vent** to vent chamber when process is over. (hold icon down for several seconds to activate) Stage will warm up from 6C to 20C which will take 10 minutes. Then, venting will begin.

If you forgot to move the latch down at the beginning and get a Vent Error, move latch down, and click Vent icon again to reinitiate vent cycle.

3 Open door.

4 Remove ring.

5 Remove wafer.

User can press Process Advance physical button for DriChuck nitrogen if they would like this option, but this is likely not needed. You can choose to ignore it too, and not hit Process Advance, and everything will sequence normally.

6 Replace dummy wafer. No need to vacuum the wafer down onto the chuck. The next user can do that.

7 Replace ring.

g SHUTDOWN

1 Close door.

2 Click on **Pump** icon.

3 Position latch on door in vertical upward position, but slightly biased so it will fall forward once pump down begins (i.e move latch so computer display shows "door open' going away when correctly positioned). *Latch being positioned vertically initiates the pump down sequence.*

If latch does not fall down once pump down begins, move to down position for the sake of future process steps and avoiding venting errors.

4 Remain at system until cross over occurs at 2.00E-1 Torr or 200 mTorr.

5 Log off ion mill computer screen.

6 Disable in Badger.

7 Problems/Troubleshooting

a Use oxygen resist softening step of 30 sec. to aid in removing resist with just acetone in an ultra-sonic bath.

b Use acetone in ultra-sonic bath to remove resist. Resist strippers at elevated temperatures should not be necessary with the Intlvac, especially if the oxygen resist softening step is employed.

c The ultra-sonics is the key because it breaks apart the surface scum on the resist that is not soluble in acetone. Without ultra-sonics, this scum just lies down on the surface of the wafer and is never removed.

Slow Etch Profile

Profile: Beam V = 200 V
Beam I = 70 mA
Accel V = 24 V

Material	Rate (Ang/min.)	Material	Rate (Ang/min)
Ag	100	Nb	20
Al	35	Ni	30
Al/Cu	5	NiCr	10
Al2O3	5	NiFe	20
Au	90	NiFeCo	5
AZ 1350 J	15	No	20
Bi	430	Pb	155
C	5	PbTe	150
CdS	50	Pd	50
Co	30	PMMA	20
Cr	20	Pt	45
CrSi	5	Rb	200
Cu	50	Re	25
Er	45	Ru	30
Fe	25	Sb	160
FeO	35	Si	30
GaAs	115	SiC	15
GaP	70	SiO2	25
GaSb	85	Si3N4 LPCVD	5
Ge	45	Sn	70
InSb	60	Th	35
Ir	30	Ti	10
LiNbO3	25	V	20
Mn	45	W	15

Fast Etch Profile

Profile: Beam V = 300 V
Beam I = 125 mA
Accel V = 36 V

Material	Rate (Ang/min.)	Material	Rate (Ang/min)
Ag	1000	Nb	200
Al	350	Ni	300
Al/Cu	50	NiCr	100
Al2O3	50	NiFe	200
Au	900	NiFeCo	50
AZ 1350 J	150	No	200
Bi	4300	Pb	1550
C	50	PbTe	1500
CdS	500	Pd	500
Co	300	PMMA	200
Cr	200	Pt	450
CrSi	50	Rb	2000
Cu	500	Re	250
Er	450	Ru	300
Fe	250	Sb	1600
FeO	350	Si	365
GaAs	1150	SiC	150
GaP	700	SiO2	250
GaSb	850	Si3N4 LPCVD	50
Ge	450	Sn	700
InSb	600	Th	350
Ir	300	Ti	100
LiNbO3	250	V	200
Mn	450	W	150