

# Ar-ion Milling Standard Operating Procedure (SOP)

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## (A) System turn ON:Pre Milling Process

### *External checks - In the service corridor:*

1. Check the chiller; it should be on while running Kauffman Source. This is used for cooling the substrate holder.
2. Check **Ar** cylinder pressure. If the pressure is less than 10 kg/cm<sup>2</sup>, the cylinder may need to be replaced. Line pressure of **Ar** should be 3-4 bar.

### *At the system - Inside clean room:*

1. Switch on all the switches on the switch-board. Please see the Figure below:

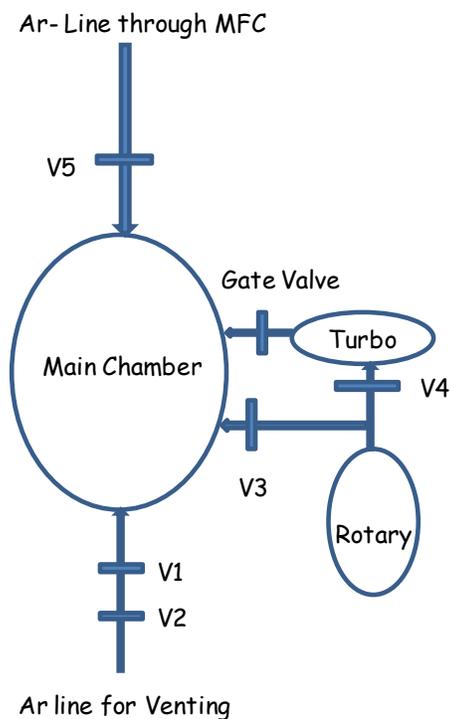


Fig: Schematic diagram of Ar -ion Milling system

2. Open the **Ar** line main valve (Knob should be downwards). To vent the chamber, open both the gate valve V1 and V2 connected to the chamber. The chamber comes to atmospheric pressure. Close both the valve V1 and V2 and the sample holder can now be removed.

3. Place the substrate on the sample holder - it can be either held in place using a clip or stuck to the holder using Ag paint or both.
4. Load the sample holder back and position the sample shutter in place inside the chamber and close it.
5. Partially open the gate valve. Switch on the rotary pump. Once the pressure is seen to drop, open the gate valve completely. Put MFC in purge mode and open valve V5 for 1-2 minutes. Then close V5 and put back MFC in OFF mode.
6. When the pressure drops below 5e-2 mbar, switch on the turbo pump.
7. Make sure that the turbo is in 'standby ON' mode. Wait for it to attain stable standby speed (666 Hz).
8. Put the turbo in 'standby OFF' mode. It now ramps to its maximum speed (1000 Hz).
9. Wait for the chamber pressure to drop below 4e-6 mbar. This takes at least 30 minutes of turbo operation at full speed.
10. Once the desired vacuum is attained, put the turbo pump in 'standby ON' mode and wait till stable standby speed (666 Hz).
11. Open the **Ar** line valve V5. Put MFC in ON mode and maintain the MFC flow rate 4-5 sccm to attain the **Ar** pressure ~ 4.3e-3 mbar.
12. Make sure the shutter of the other two sputter guns are closed completely. These guns can be used for post milling SiO<sub>2</sub> deposition in the same vacuum. User has to take separate training for this.
13. Turn on the DC motor connected to substrate holder. This will provide uniform milling rate. The switch board where the adapter of DC motor is connected is interlocked with the chiller supply from back side of the chamber. Without chiller user should not operate any process.
14. Once the **Ar** pressure is stable, switch on the KRI source controller and wait for 2 min.

15. KRI source controller parameter setting:
- It can be operated in two modes: Auto and manual.
  - Depending on the requirement, all the parameters can be changed in manual mode.
  - Generally user has to change the beam current and voltage values to get the desired milling rate.
  - Neutralizer current should be equal to the beam current.
  - User should not change the other parameters without the guidance of SO or experienced user.
  - Please refer the Table below:

**Table 1. Maximum argon ion beam current for 4-cm Microdished™ molybdenum defocused ion optics.**

Beam, V	Accel, V	Beam, mA
200	40	4
300	60	12
400	80	23
500	100	33
500	300	56
600	120	46
700	140	61
800	160	78
900	180	94
1000	200	113
1000	500	140
1100	220	134

16. After setting all the desired values, put the discharge in enable mode by pressing **discharge enable** button (LED should glow green). Check inside the chamber, there should be glow of filament. Wait for 2-4 minutes.
17. Turn the beam enable by pressing **beam enable** button (LED should glow green).
18. Initially it will take 1-2 minutes to set all the parameters, then user can open the shutter for pre-calculated time to start milling process. Ar pressure should be stable.
19. Once it is done, switch off the beam by pressing **beam enable** button (LED should glow red), and wait for 2 minutes.
20. Put discharge in off mode by pressing **discharge enable** button (LED should glow red) and again wait for 2 minutes. Switch off the main switch of KRI source.

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#### **(B) System turn OFF:**

- Once the milling is completed, close the gate valve completely.
- To unload the sample, vent the chamber with Ar by following the step-2 and remove your substrate.
- In case user doesn't want more milling run, follow step-4 and jump to step-27 onwards else follow step-3 and 4.
- Close valve V4 (connected to the Turbo) and open valve V3 (connected to the chamber). By doing this we are connecting chamber directly to the rotary pump.
- When the pressure drops below  $5e-2$  mbar, close V3 and open V4.
- Open the gate valve slowly and follow the step-7 onwards for further operation.
- Switch off the turbo pump. Close valve V5 and Ar line main valve.
- Once the speed of turbo drops below 400 Hz, it will vent automatically and user can switch off the rotary pump.
- Switch off all the switches before leaving the system.

#### **External checks - In the service corridor:**

- Turn OFF the chiller in case none other systems are using it.