DC Magnetron Sputtering System: Introduction

This page is under revision

SAFETY FIRST

This manual is not intended as a substitute for actual instruction. Please check with your instructor before running the system.

Before operating the sputtering system, keep the following safety guidelines in mind:

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In addition to the hazards listed above, the system can be damaged by not following procedures properly. The most important of these is

- DO NOT OPEN THE VENT VALVE OR ROUGHING VALVE WHILE THE HI-VAC VALVE IS OPEN. THIS WILL BURN THE DIFFUSION PUMP OIL AND CAUSE THE OIL TO COAT THE INSIDE OF THE CHAMBER. DO NOT, I REPEAT, DO NOT OPEN THE VENT VALVE WHILE THE HI-VAC VALVE IS OPEN UNLESS YOU WANT TO SPEND THE REST OF THE SEMESTER AND YOUR SUMMER VACATION CLEANING OUT THE CHAMBER.

- Do not open the hi-vac valve until the pressure is below 10^-6 torr. Pressures above this range will cause the pump oil to backflow into the chamber.

- Do not open the hi-vac valve until the cryotrap has been cooled down for at least 30 minutes. Be careful not to overfill the cryotrap funnel, as this will freeze the hi-vac valve seal.

- Do not turn on the cold cathode gauge when the pressure is above 1mtorr. This will cause a buildup of particles at the gauge, and it will need to be cleaned or replaced. Also, do not let the CC gauge run while sputtering, for the same reason. Only use it to check the base pressure, before the MFC valves are opened.

- Follow clean handling protocols when handling samples, sample holders, and other parts that come into contact with the inside of the chamber.

DC Magnetron Sputtering Principles

Sputtering is a physical vapor deposition process used to deposit a film of atoms onto a substrate. Target atoms are bombarded by an energetic ion which dislodges them. In a high vacuum, these atoms will disperse in random directions until they find a suitable substrate to land on and stick to. If these atoms are turned into charged ions, their paths can be directed by a voltage. This can be used to an advantage, directing the target atoms onto our substrate in a uniform fashion. We can then grow a film of desired thickness by knowing the film growth rate and choosing the correct sputtering time.

The parts of the sputtering system are:

- Four substrate holders, capable of heating the sample to ____C. A positive bias is applied to the substrate as well.
- target. This is the material we want on our sample. A negative bias is applied to the target.
- Magnet. This is placed beneath the target. It makes the bombarding ions circulate near the target and away from the sample.
- Collimator ring. This confines the plasma to the target area being used.
- Shutter. This is between the target and substrate. Closing it prevents target ions from reaching the substrate.
- Target rotator. There are three target holders to choose from, and the holders can be rotated to coincide with the desired substrate holder
- MFC inlets. These gas inlets allow our bombarding atoms in so they can get ionized and hit the target.
- Diffusion pump. This pump heats up a heavy silicone-based oil, and the oil particles are directed in such a way as to push the air from the chamber towards the foreline, then out to the roughing pump.
- Roughing pump. This pump is used to pump the system down from atmosphere.
- Power supplies to targets.
- Optional RF power for use with insulating targets, and to keep charges from building up on the

target.

Operation Procedures

- Pumping the chamber down from atmosphere to low vacuum

    1. While holding the bell jar, remove the pin from the support post and lower the jar onto the lip of the sputter chamber.
    2. Seat the jar on the lip, making sure it is centered.
    3. Close the foreline and open the roughing line.
    4. Pump down the chamber until the gauge (?) reads 1mtorr.

- Pumping the chamber down to high vacuum using the diffusion pump

    1. Quickly close the roughing line and THEN open the foreline.
    2. Let the roughing pump work on the foreline pressure to reduce it.
    3. Close the foreline and THEN quickly open the roughing line.
    4. Let the roughing pump work on the roughing line to reduce the pressure there.
    5. Again, let the roughing pump work on the foreline by switching valves as described above. At all times, remember NEVER to have both the foreline and roughing valves open at the same time. This will cause too high a pressure at the diffusion pump, and oil will backstream into the chamber.

- Bringing the chamber up to atmosphere

    1. Make sure the MFC valves are closed.
    2. Make sure the hi-vac valve is closed before letting in atmospheric gas. The diffusion pump is not designed to handle such high pressures. This is the part where you can really mess up the system. Pay attention to what you're doing!
    3. Make sure the convectron gauge is off.

4. Make sure all power supplies are off to the targets. Do not turn the sputterer into a lethal weapon!

5. Now, both the diffusion pump and roughing pump should be on, with only the foreline valve open.

6. Open the vent valve. A surge of air from the line will come into the chamber.

7. Close the foreline and THEN open the roughing line to pump out the vent line.

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