

Electron-Beam Deposition Laboratory

The purpose of this lab is to demonstrate metal deposition using the electron-beam evaporator, and patterning of the deposited metal on your silicon substrate. Half the class will spin on and pattern positive photoresist on your wafer, prior to metal deposition (lift-off), and the rest will pattern the deposited metal after deposition (etching). Once the wafers are prepared for deposition, they will be fixed on the electron-beam substrate chuck and deposited with metal, as follows.

1. Vent chamber
 - a. Make sure latch is down
 - b. “Shift/Function”
 - c. “Auto Vent” – light goes over button
2. Place sample “umbrella” in chamber – raise to level of crystal monitor
3. Place target in chamber
 - a. Open gun shutter – “Gun Shutter”
 - b. Insert crucible and metal - capable of holding up to 4 crucibles
 - c. Close gun shutter – “Gun Shutter”
4. Close chamber and pump down
 - a. “Shift/Function”
 - b. “Auto Pump” – activates roughing pump, then cryopump automatically
 - c. MKS TC1 must pump down to at least $100\mu\text{m}$, system then switches automatically to cryopump, and pumps down to 5×10^{-6} Torr (IG1)
5. Switch on ion gauge (IG1) after pumping down
6. Switch on main power
 - a. Ensure that voltage knob is turned to zero (fully counterclockwise)
 - b. Ensure that current knob is turned to zero (fully counterclockwise)
 - c. Flip switch and wait for 3 minutes before turning on current emission control
7. Switch on Inficon XTC/2 Deposition Controller, and enter *material density* value and *z-number* from slide chart
 - a. “Program”
 - b. Scroll through values using “ Δ ” and “ ∇ ”
 - c. Enter data
 - d. “Program”
 - e. Clear crystal monitor – “ Δ ” then “Clear”
 - f. “Start”
8. Switch on XY sweep power
9. Switch on rotation for planetary holder – “Rotation Power”
10. Adjust voltage knob on main panel to approximately 6.5kV
11. Adjust emission control knob
 - a. Increase to approximately 0.015A and open gun shutter
 - b. Check beam position through view port
 - c. Adjust beam first with voltage adjustment knob, then sweep, to fine tune the beam position
 - d. Close chamber viewports

- e. Increase the current to 0.050A in 0.005A increments, *slowly* – wait 1 minute between incremental increases
 - f. Once deposition has begun (deposition rate on crystal monitor (kA/s) starts increasing, you can increase the current more rapidly
 - g. Increase until rate reaches approximately 1.5A/s
12. Shutdown procedure when deposition reaches 2000 A
- a. Close gun shutter
 - b. Turn down first current, then voltage
 - c. Switch off power to current control, wait for 3 minutes
 - d. Switch off main power
 - e. Switch off ion gauge
 - f. Switch off chuck rotation power
 - g. “Auto Vent” and remove sample

Following deposition, the wafers with patterned photoresist on them will be developed using lift-off.

1. Place the wafer in a beaker of acetone
2. Fill ultrasonic bath with water, to 1 inch from the top of the bath
3. Place container-suspension plate over bath, and place beaker in appropriate hole, so that the bottom of the beaker is immersed in the solution
4. Make sure that the beaker is *not* touching the bottom or side of the water bath
5. Switch on the oscillator by either turning switch to left, or to the right for timed sonication
6. Observe the wafer for complete removal of the resist

For the wafers with no prior photoresist patterning, spin on resist and pattern after deposition, and etch metal using standard aluminum metal etchant.

Following the metal patterning and development using both lift-off and etching, measure the resistivity of the deposited metal using the four-point probe, and compare to literature source values.