E-beam Evaporator

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Vacuum

- Pressure units

  atmosphere Torr bar pascals

  1 760 1 101×10^3

  1 Torr ~ 1/760 atm ~ 1/1000 atm= 1 mbar

- In Chamber

  10^{-5} mbar = 10^{-5} Torr

  Use a cryogenic pump

- Pumping sequence

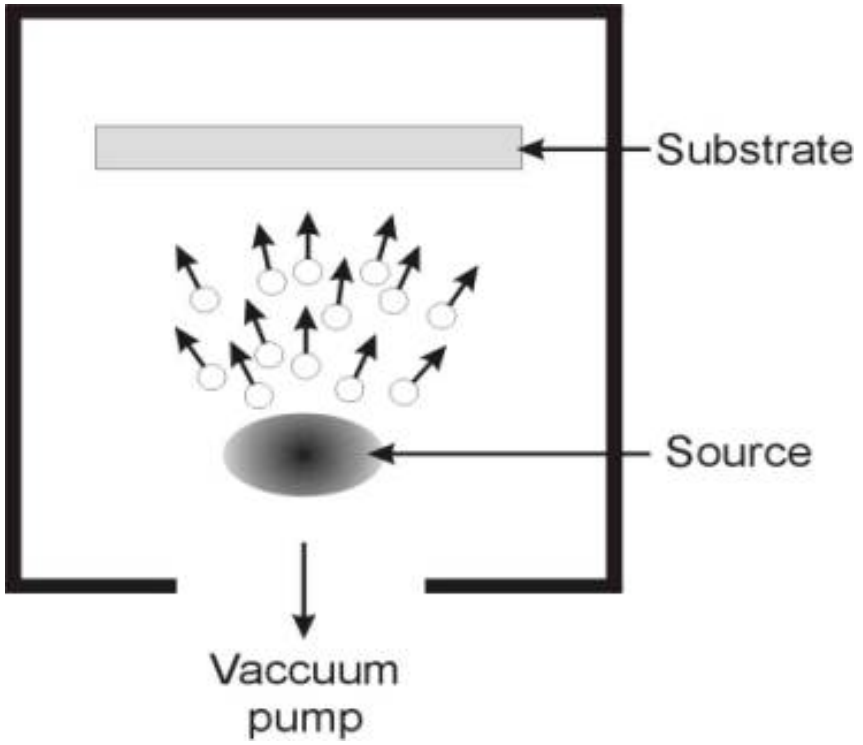
  Rough pump atm → 0.01 mbar in <15min

  Cryopump →$10^{-5 / -6}$ mbar in about 1hr

BOC Edwards A306 Evaporator

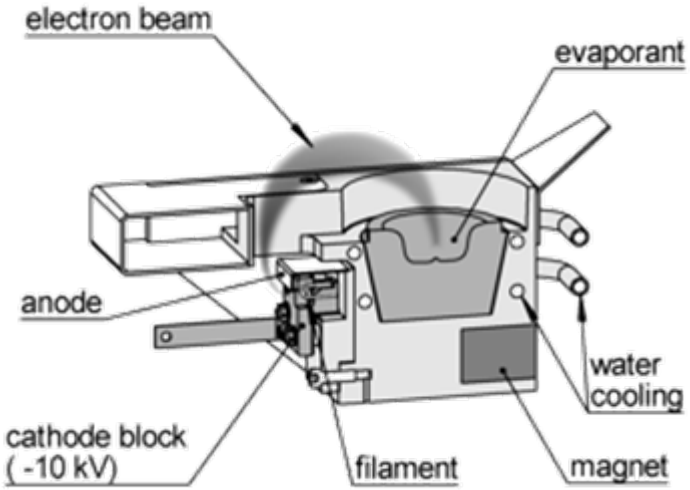
Technique

- Vacuum chamber at 10^{-5} mbar
- Use a beam of electrons to melt metal (source)
- Vapor deposits onto sample (substrate)



Principle of e-beam evaporator operation

- The electron emitter is designed with 270° beam deflection
- Temperature ~ electron current



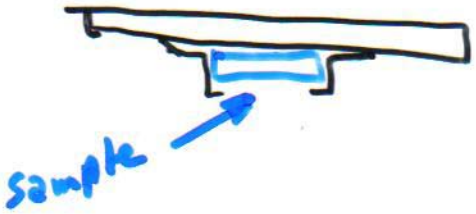
Melting, Boiling Points

Metal	Melting point (°C)	Boiling point (°C)
Al	660	2500
Au	1062	2800
Ti	1657	2600
Cr	1890	3200
W	3410	5500

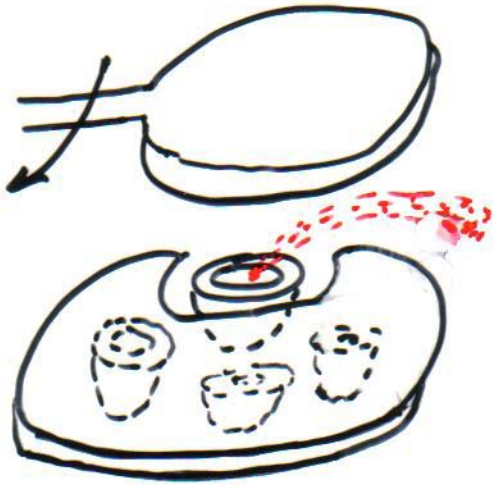
Cost: per 50 gm

Metal	Price (CAD)
Al	$25
Cr	$50
Au	$1300, now?
Pt	$2600

sample holder



thickness monitor



Shutter

four crucibles

Thickness Monitor

- Metal deposited →
  Frequency change →
  Constants (density,
  acoustic imped. “Z”,
  “Tooling”)

→ Thickness

→ “Tooling” is a solid angle correction factor calculated with geometric formulae

Notes :

1. Evaporator is for approved metals only. Some metals are toxic. Some are reactive and will foul the cryopump resulting in expensive repair.

2. Typical pressure during evaporation is 1 to 3 x 10^{-5} mbar range.

3. Do not run electron gun if pressure is greater than 6 x 10^{-5} mbar (filament will burn out).

4. Very gradually/slowly increase electron current. The pressure will increase due to absorbed water vapor, adsorbed air being heated off all the surfaces inside the chamber.

5. Do not run for more than 30 minutes at currents greater than 250 mA.

6. Each metal requires a special crucible material (graphite, carbon, refractory, intermetallic).

7. Crucibles are about 2 cc volume. Fill 0.6 to 0.8 only.

8. Typical deposition rate is 0.1 nm/sec

9. If sample is put closer to source, evaporation is faster but uniformity is worse for a large sample and sample will get hotter.

10. There is no sample cooling so doing a long, hot evaporation will make the sample get hot.

11. Evaporated films more than 1 micron take a long time, uses lots of source metal and will have adhesion, stress problems.

12. Cross contamination (from other metals) : inspect the lip near the crucible.

13. See www.lesker.com and http://www.ee.byu.edu/cleanroom/metal.phtml for tables on metals, evaporation rates, etc.