

PECVD

- APCVD LPCVD UHVCVD MPCVD MOCVD
- CVD “chemical vapor deposition”
- Substrate is exposed to volatile species that react and deposit onto a surface.

See Madou (Fund. Microfabrication) and
review paper by D. Sheel, Int. Conference Coatings on Glass, Germany (2002)

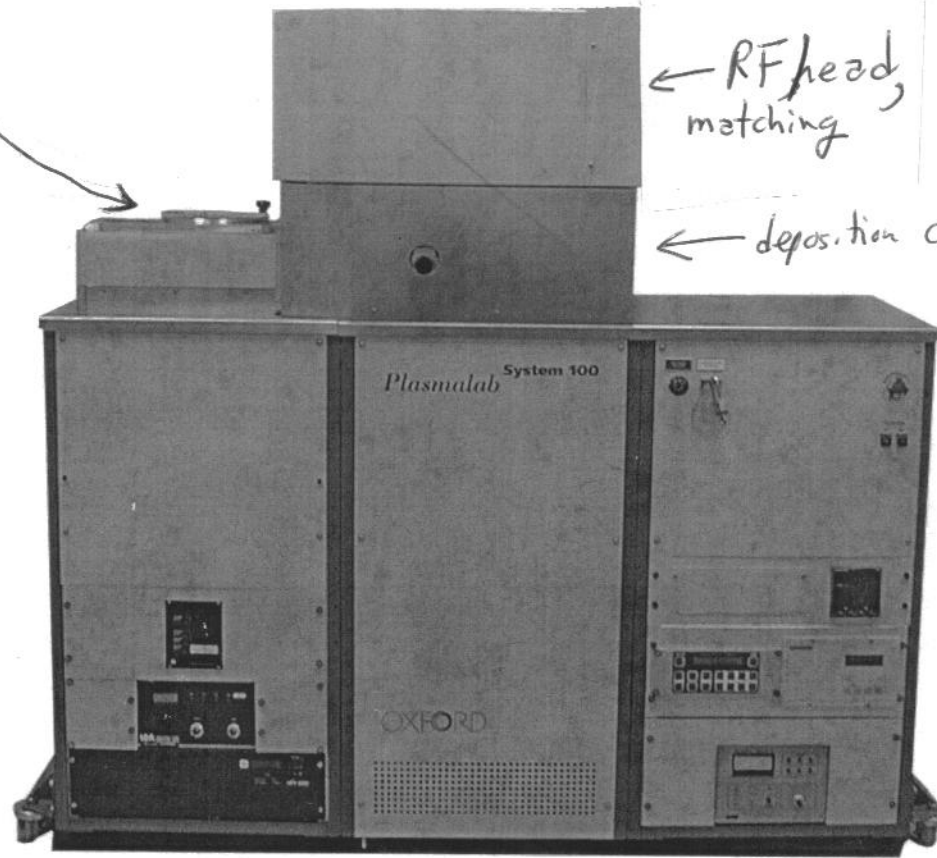
- PlasmaLab System 100 PECVD (Oxford Instruments www.oxinstr.com)
- Deposits SiO₂, SiN, SiON and phosphor-doped SiO₂ up to several microns thickness at rates typically 10 to 300 nm per minute.

Load
Lock

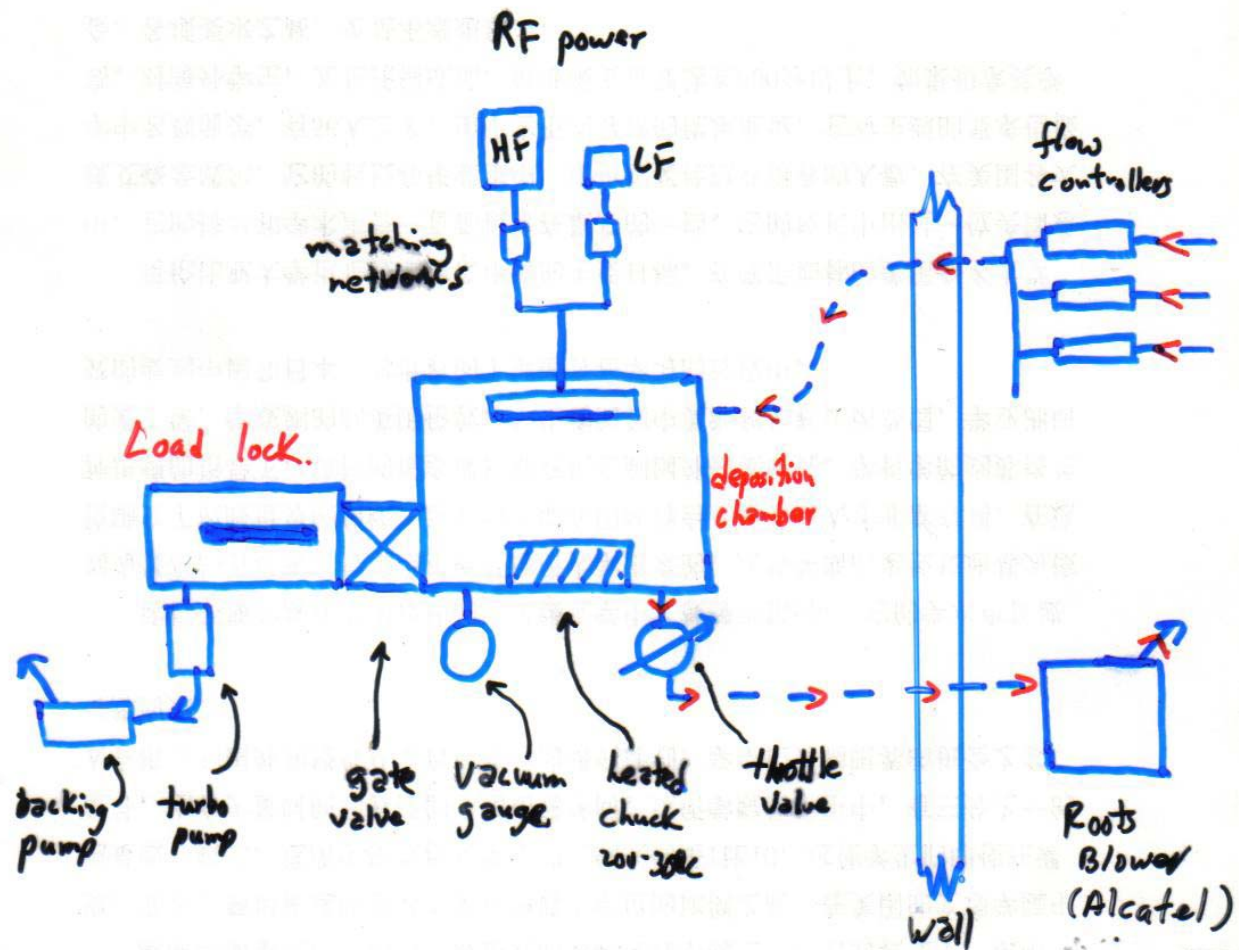


← RF head,
matching

← deposition chamber



RF supplies ↗



- Nerlab RTE7 chiller ^{and booster pump} to supply 60°C water to chuck, sidewalls, RF coils.
- N₂ gas purge needed for Roots blower.

G, F, P,
RF, T, t

Mixed Frequency PECVD

At 13.56 MHz (HF) ions do not respond to RF field.

At 100-350 kHz (LF) ions can respond and bombard the growing film.

Mixing of HF and LF allows control over bombardment and hence control over film stress and film density.

(variable capacitors used to match impedance of RF power supply with the plasma)

PECVD Plasma Processes

theoretically

Oxide:



Nitride:



Oxynitride:



→ But a cvd film is **not** stoichiometric

SiN Deposit

1. Place sample into load lock.
2. Ensure deposition chamber below 1 mTorr and chuck is at 300 C.
3. Purge with 1000 sccm nitrogen gas for 1 minute.
4. Do a chamber clean with nitrogen 1000 sccm , 100 watts HF.
5. Sample then goes into deposition chamber.
6. Flow SiH_4 450 sccm, NH_3 10 sccm, N_2 1000 sccm N_2O 1000 sccm at 1800 mTorr. Wait to stabilize then alternate LF 160 watts, 10 sec HF 200 watt 10 sec.
7. Deposition rate is 100 nm per minute.
8. Sample is moved back to load lock. Very hot. Wait 15 minutes before taking out.

Common problems

- Poor adhesion – change or lengthen surface preclean step
- Surface interactions – deposit SiNx at <300C on InP to avoid rough/lumpy films - or use NH3-free SiNx
- Particles – if seen as silica dust in showerhead pattern on wafers then need to search for air leaks in gas lines or behind showerhead.
- Particles - if random scattering of particles check chamber/showerhead condition – may need plasma cleaning or sandblasting clean.
- Pinholes – particles drop on sample then hop off.

Notes

- The gasses available are 5% SiH₄ in 95% nitrogen, ammonia, phosphine in argon, N₂O, N₂, argon, He and 80% CF₄ in 20% oxygen.
- In order to deposit good quality films, the sample is placed on a chuck that is held at 200 C to 350 C.

*** Therefore the sample must not have any photoresist or any material that will melt/burn/volatize at these temperatures. ***
- Cleanliness and cross contamination has to be closely monitored in order to get clean, consistent, reproducible films from the pecvd. We require a proposal form to be filled giving details on samples, sizes, film type, thickness.

Vacuum

- Pressure units

atmosphere	Torr	bar	pascals
1	760	1	

so 1 Torr \sim 1/760 atm \sim 1/1000 atm = 1 mbar

1 mTorr is almost 10^{-6} Atm

- Rough vacuum 0.01 Torr, high vacuum 10^{-6} Torr ultrahigh vacuum (UHV) 10^{-11} Torr

- Vacuum pumps

Roots blower for the deposition chamber. Spinning heavy lobes, noisy, runs hot.

Turbo pump on load lock \rightarrow very high speed rotor 15,000 rpm

do not drop samples, nuts, screws into turbo pump

- Pumping sequence

Load lock goes from atm \rightarrow 0.01 Torr in 5 min using roughing pump and then turbo.

Gate valve opens and robot arm loads sample into deposition chamber which is always below 1 mTorr.