Vacuum

- Pressure units

atmosphere	Torr	bar	pascals
1	760	1	

so 1 Torr ~ 1/760 atm ~ 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

oil/rotary pump, Roots blower

diffusion pump, cryogenic pump, ion pump, getter pumps

turbo pump → very high speed rotor 20,000 rpm

do not drop samples, nuts, screws

do not bump, jar

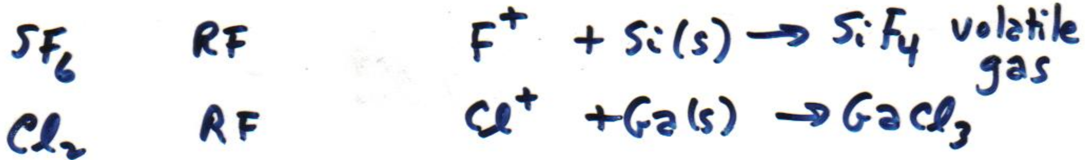
- Pumping sequence

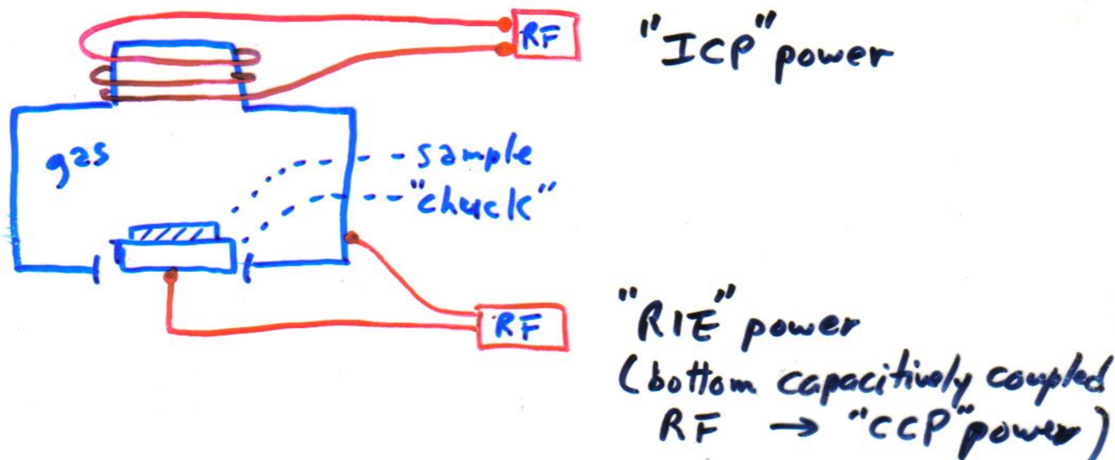
Rough pump atm →0.01 mbar in <15 min, then turbo pumping with an exponential drop

Engineering Library "Vacuum technology"

Ion assisted etching Principle

gas + energy → plasma → attacks surface

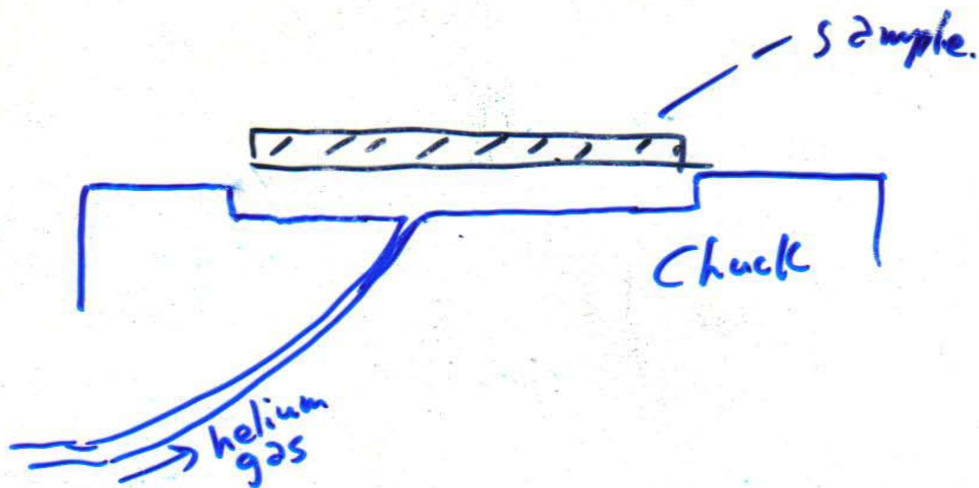




→ RF + coax cables + plasma + coil form an RF circuit

→ RF delivered to plasma = RF_{out} − Reflected Power (minimize)

Coarse and fine variable capacitors are adjusted with an analog circuit (Auto tune) or by toggle switches (Manual tune).



Helium gas backside cooling.
Electrostatic clamping to hold down
4" dielectric material.

Small pieces → use a carrier (sapphire)
and heat conducting paste on back

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chilled water → cool turbopump, cool the RF
power supplies, cool the ICP coil.

"Phantom" Etcher – SF_6, CHF_3, He, O_2

"Minilock" Etcher – Cl_2 BCl_3 Ar, H_2, O_2

(www.triontech.com)

Recipe.

gases
flow rate (standard cc/min) = (sccm)
ICP (watts)
RIE (watts)
pressure (mTorr)
time (seconds)

minimize an 8-dimensional manifold.

Factors

- adsorbed air, water vapor on chambers and sample
- temperature of sample
- density of pattern
- size of sample
- depth of pattern (aspect ratio)
  (to do MEMS - use a Deep Silicon etcher - Bosch process)
- selectivity - material to be removed versus material you want to keep
- time dependencies

→ No microscopic theory of etching that can be used in computer simulation

- Seek research papers with systematic studies
- do many trials/tests with samples
- use tested recipes from other users

(Each etcher is different)

Notes

- No plastic, wax, sticky/gooey compounds in etcher.
- Check cleanliness of chamber (loose particles, residues of fluorides, nitrides, oxides, hydrides). Wipe down with wipe/alcohol. Be careful not to rub the protective black coating on the edges. The "Clean" recipe only removes organics.
- Learn the color/intensity of the plasma. Good for diagnostics.
- Make sure back side of sample is smooth, clean.
- To improve thermal conductance one can use a tiny amount of "Mung" or "Cool Grease" or "oil".
- Do a conditioning run (no sample inside) to check plasma condition/stability, to minimize reflected RF power and to warm up and degas chamber walls.
  → Quickly load sample and pump down.
- Samples can get hot. Try etch/wait/etch/wait ...
- SPR511 photoresist is better than S18– for ion assisted etching
- After etching, allow time for sample to cool before venting the etcher and removing sample.
- If there is a noticeable smell after etching, add a long pumping and flushing steps at the end of the recipe.