Dry Etch

- Physical etch is highly anisotropic – better than wet etch as features size decreases. Ar ions are used for sputtering (removal of material through momentum transfer).
- Can also be chemically reactive, directionality with chemical selectivity (Reactive Ion Etching)
- F or Cl containing ions are used for reactive etching. The etchant species diffuse to the surface, are adsorbed react chemically, leading to volatile products which are pumped away from the chamber. Chemical etching is less anisotropic.

Si RIE – example:

\[ 4\text{CF}_4(g) \rightarrow 4\text{CF}_3(g) + 4\text{F}(g) \]
\[ 4\text{F}(g) + \text{Si} \rightarrow \text{SiF}_4(g) \]
Plasma Etching

- Plasma is the fourth state of matter and is a cloud of charged and neutral species (radicals, ions, protons, neutrons, and electrons) that exhibit collective behavior.
- Plasma is generated by high voltage to cause ionization and excitation. The substrate is typically placed on a grounded electrode. The formed species are accelerated towards the substrate and etch it physically and chemically.
- Insulating materials will not sustain plasma since the positive ions will charge the insulator and the plasma will be terminated. Therefore RF power (typically at 13.56 MHz) is used with insulating materials (electrons are mobile at > 100kHz and ions are not).
- Inductively Coupled Plasma (ICP) is a type of plasma source in which electrical current is produced by electromagnetic induction (magnetic fields changing with time).