Introduction to Plasmas & Chemistries for Etching Novel Materials

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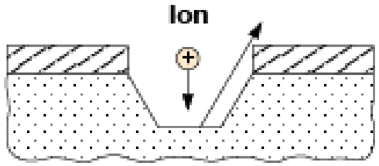
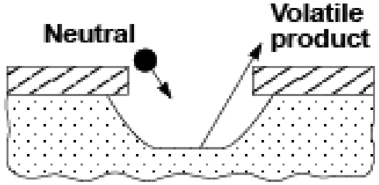
👍 *Creating, Protecting & Monetizing IP*

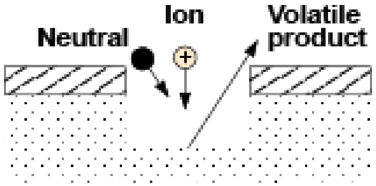
5 Classes of Mechanism



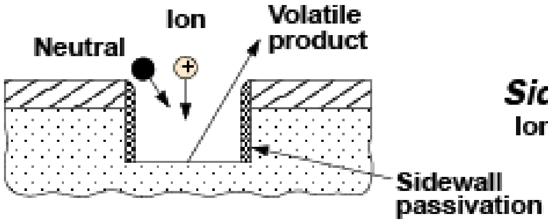
Sputter
Etching



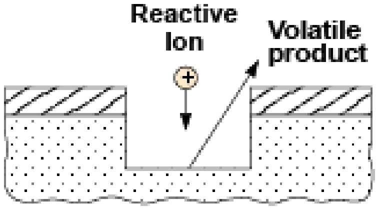
Chemical
Etching



Accelerated
Ion–Assisted Etching



Sidewall-Protected
Ion-assisted etching



Reactive Ion
Etching

Plasma Etching Options

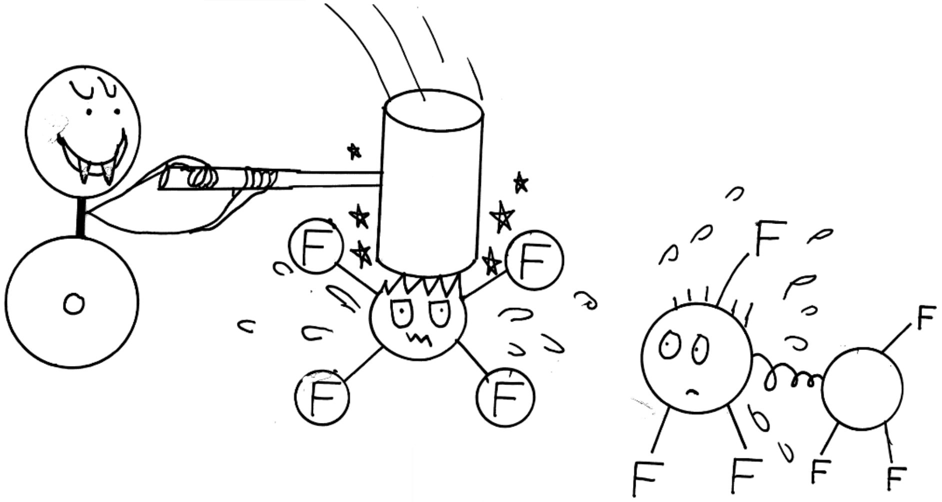
- Physical/Universal

- Sputtering by Ion Bombardment
  - Energetic Ion Beam (a plasma)
  - Sheath biased plasma

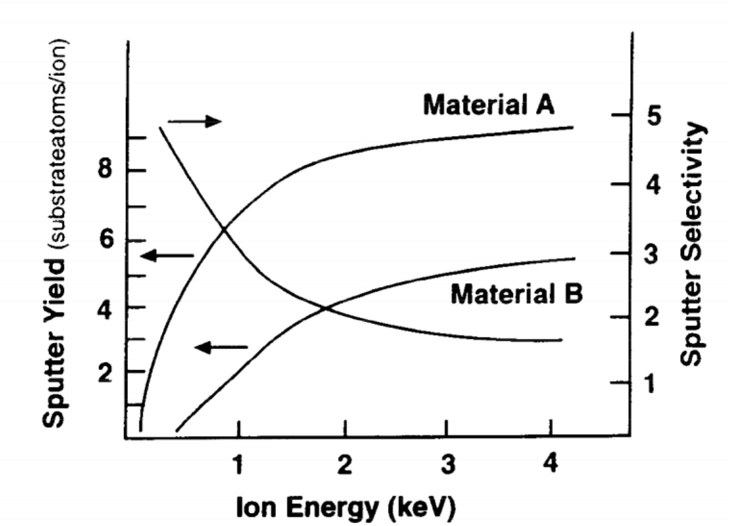
- Plasma induced vaporization
  - Thermal plasma
  - Laser Plasma

Plasma Etching Options

- Physical /Chemical
    - Capacitive in reactive ambient
    - Inductive in reactive ambient



Factors & Process Requirements



- Amount/Thickness/Rate

- Uniformity

Tradeoff Possible

-Selectivity

Chemical Selectivity
Threshold/Yield

Physical & Ion-Assisted Chemical

Plasma Applicator Uniformity

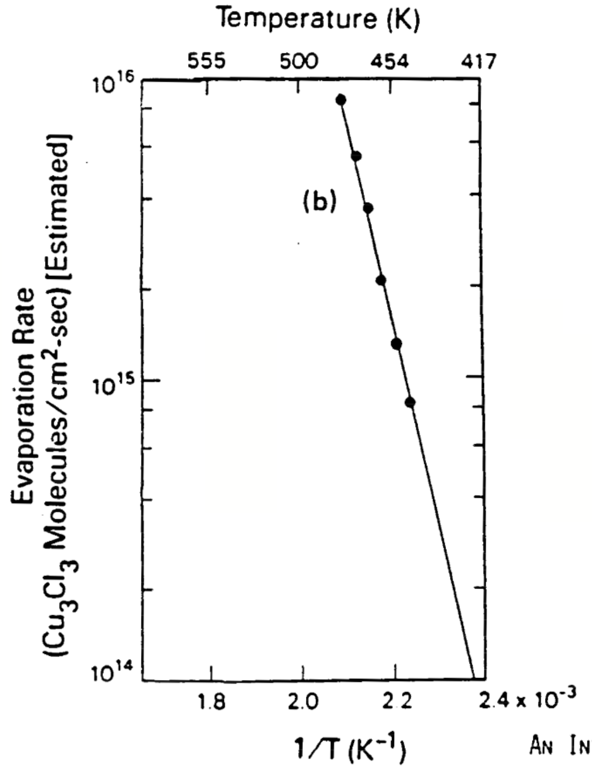
Chemistry Options to Form Volatile Products

- Surface Chemical Gasification (purely)
  - Stable Gases
  - Radicals
  - Ion Assisted

		Substrate									
Species	Typ.Feed	Si	SiO_2	Si_3N_4	$C_xH_yO_z$	GaAs	Al	Cu	W	WSi_x	Cr
O	O_2, N_2O				☺						
F	NF_3, SF_6 CF_4+O_2	☺	☹	☹					☺	☺	
Cl	Cl_2, CF_xCl_y $HCl+O_2$	☺				☺	☺	☺	☹	☹	☺ ($+O_2$)
Br	Br_2, HBr, CF_3Br	☺				☺	☺		☹	☹	
I	HI, I_2	☺				☺					
H	H_2	☹	☹			☹					
CF_x layer	CHF_3+O_2 C_4F_8, C_3F_6, $CF_4+C_2F_6$		☺	☺							

Major Control Variables

- Surface Temperature
- Energy Flux
  - Ion Energy
  - Ion Flux
  - Laser fluence/pulse rate
- Plasma Gas Composition



AN INVOLATILE PRODUCT CAN LIMIT ETCHING RATE