ME 517: Micro- and Nanoscale Processes

Lecture 8: Microfabrication
- Additive and Subtractive Techniques II

Steven T. Wereley
Mechanical Engineering
Purdue University
West Lafayette, IN USA

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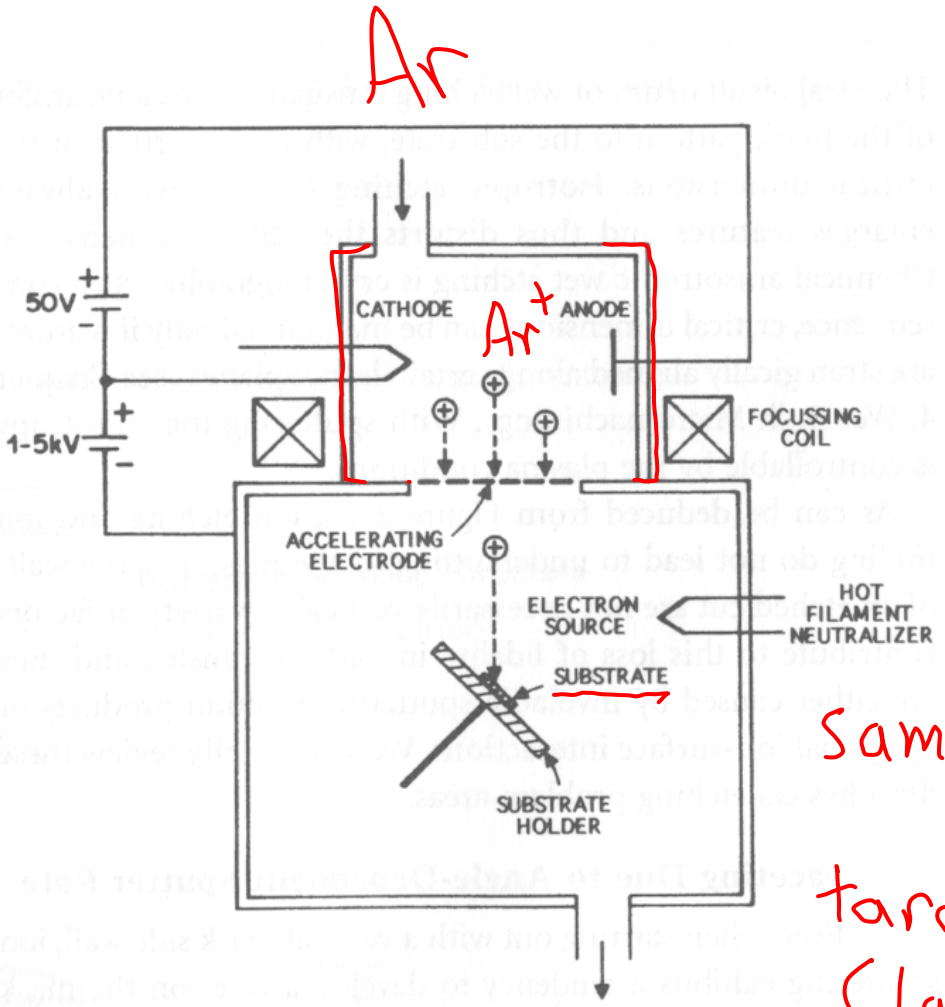
PURDUE
UNIVERSITY

Sputtering and Ion-Beam Techniques



Ion Energy (eV)	Reaction
<3	Physical adsorption
4–10	Some surface sputtering
10–5000	Sputtering
10–20 K	Implantation

sample being machined
or
target to be vaporized
(later)

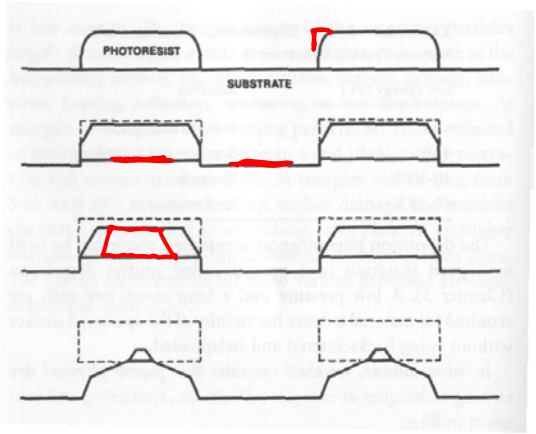
Physical Etching Characteristics

Rates of ~ 10 nm/min

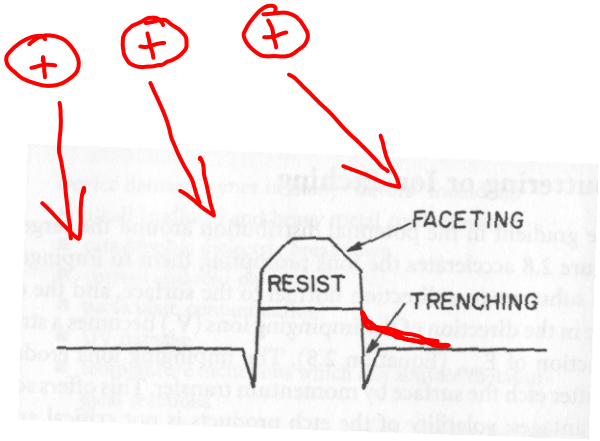
Faceting due to angle-dependent sputtering rate

relative etch rates

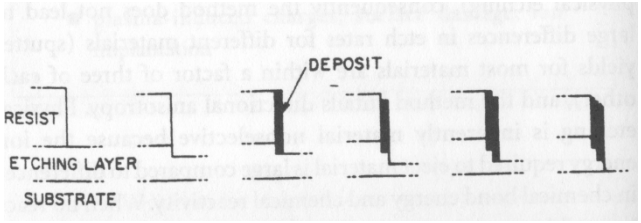
time



Ditching



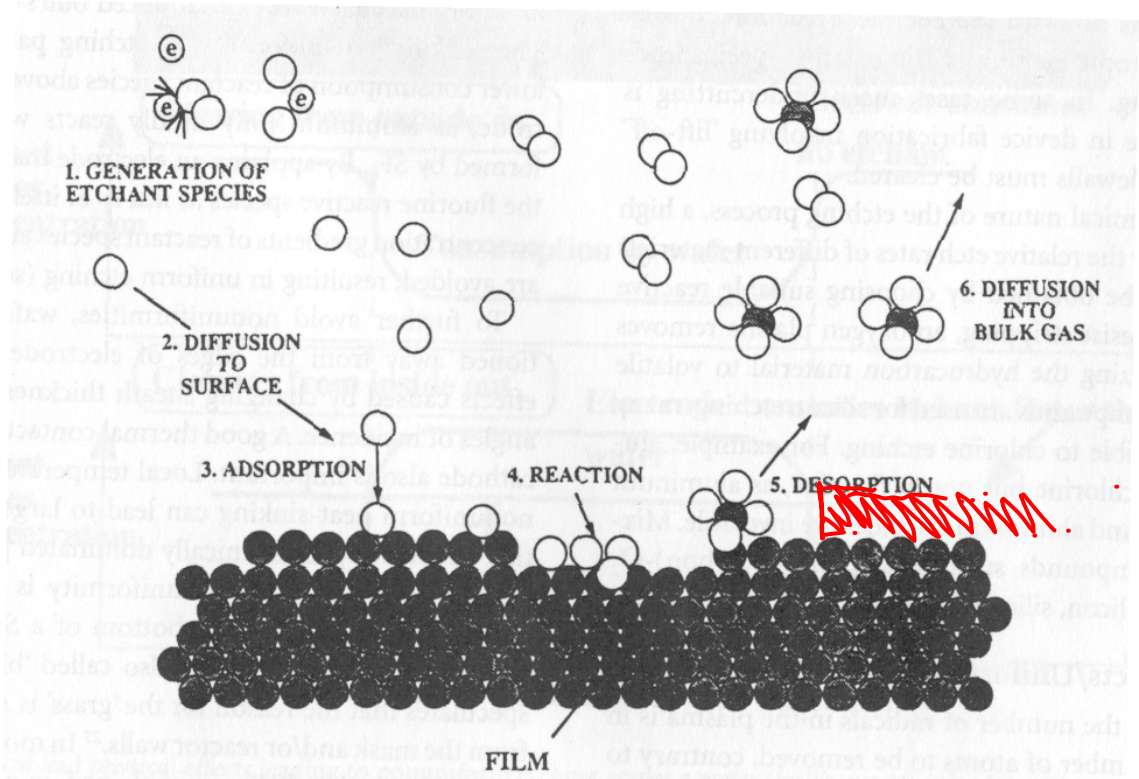
Redeposition



time

characterization

Chemical Etching

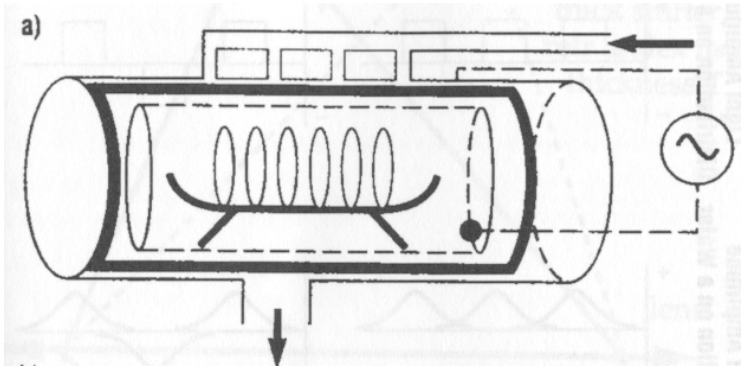


1. Energetic electrons of 1-10 eV energies impact a chemical species such as CF_4 generating CF_3^+, $\mathbf{CF_3}$ and **F**.
2. Reactive species diffuse to the surface where they adsorb.
3. Species diffuse over a surface until then react.
4. Reactive species desorb.

diffusion-dominated
isotropic
under cutting

Chemical Etching Techniques

- Reactor design



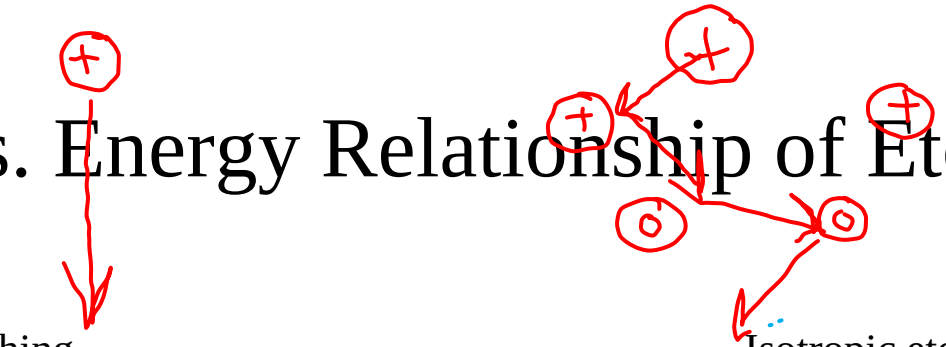
characterize

• Rate of reaction are controlled by ion and radical concentration. Can approach 1000 nm/min.

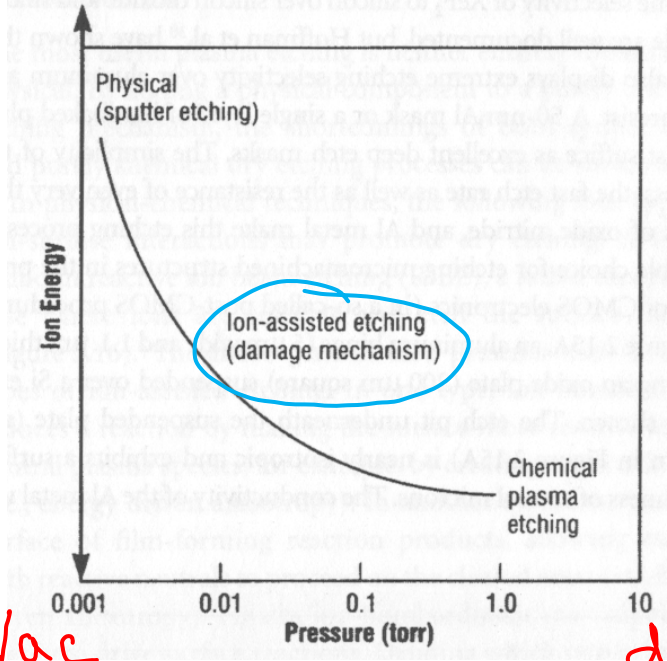
• Ionization energy provides the necessary activation and controls the degree of anisotropy.

• Uniformity is dependent on the concentration of reactive species and products. Rate can be limited by reactive products.

Pressure vs. Energy Relationship of Etching



Anisotropic etching ⟷ Isotropic etching



Vac denser

torr = 1mm Hg

760 mm Hg = 1atm = 101 kPa