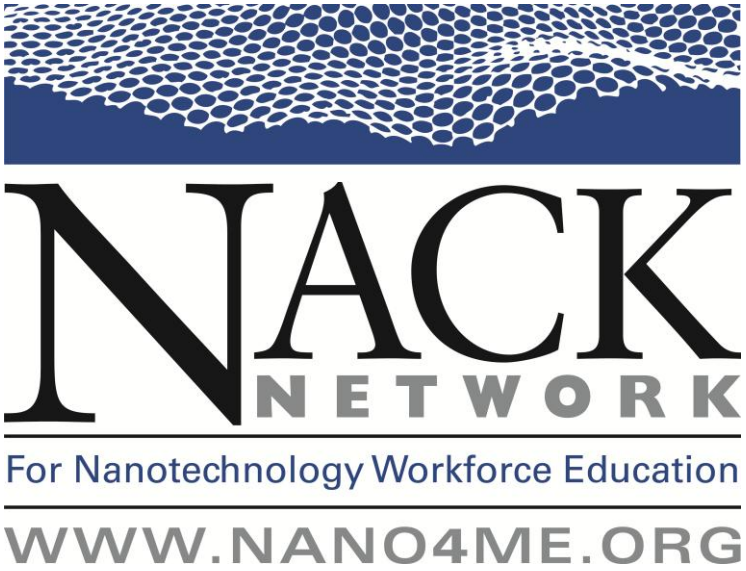


Basic Nanotechnology Processes

E SC 212

Unit 2
An Introduction to Uses of Plasma in Processing

Lecture 4
Subtractive Processes and Etching

Outline

- Subtractive processes
- Cleaning and etching
- Dry cleaning
- Dry etching

Subtractive processes

- There are two types: (1) those used for cleaning and (2) those used for etching.
- The subtractive processes that are based on using plasmas are what is termed dry processes

Cleaning and Etching---a question of degree

Cleaning Processes

- Cleaning (term used for wet and dry processes). Term used when removing very thin films (residues, “scum”) --- film may be as thin as a few monolayers.

- De-scumming (term used for wet and dry processes)

- Ashing (term used for dry cleaning based on oxygen plasmas)

Etching Processes

- Wet etching
- Dry etching

Dry Cleaning

- Always uses a plasma*
- Sputter cleaning (purely physical; e.g., Ar plasma bombardment)
- De-scumming and ashing (can vary physical and chemical components; e.g., oxygen plasma)

*Can dry clean with “dry ice”; i.e., solid carbon dioxide pellets.

Dry Etching

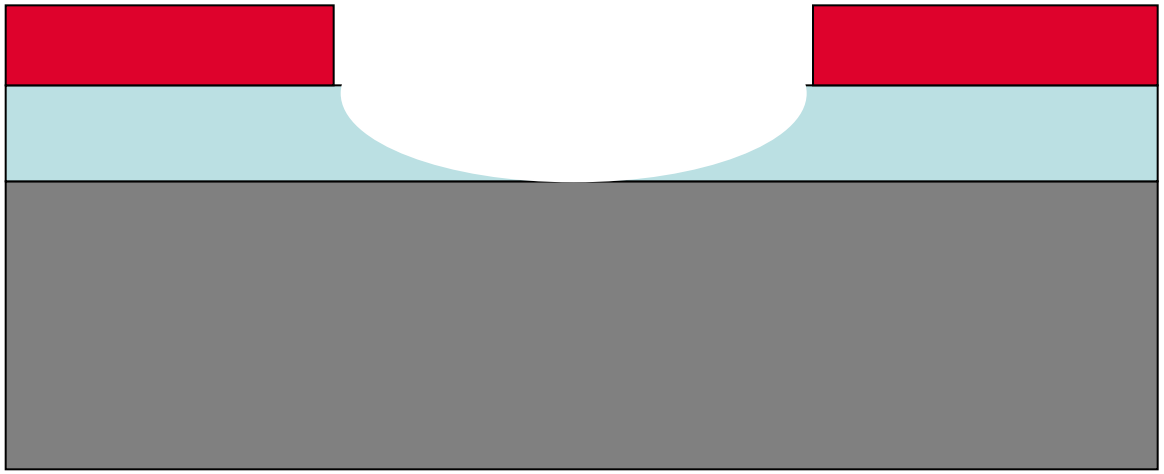
- Always uses a plasma
- Sputter etching (purely physical)
- Reactive ion etching (can vary physical and chemical components)

Some terminology

- Reactive ion etching (RIE) is sometimes called plasma etching
- RIE always places the substrate on the cathode
- The term “Plasma etching” is always used if the substrate is placed on the anode
- So---3 terms to keep straight: dry etching, RIE, and plasma etching

Dry Etching

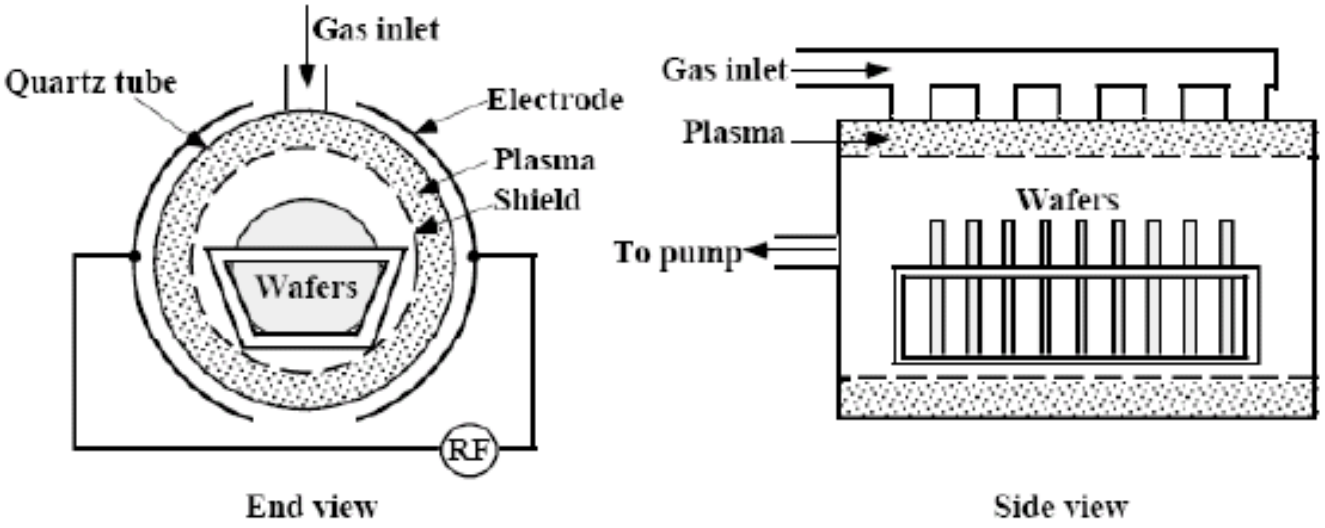
- Want reproducibility
- Want to remove material at rates of 1-1000nm/min.
- Want selectivity (only etch what you want etched)
- Want to control the etch profile



Dry Cleaning Example: Barrel Reactor

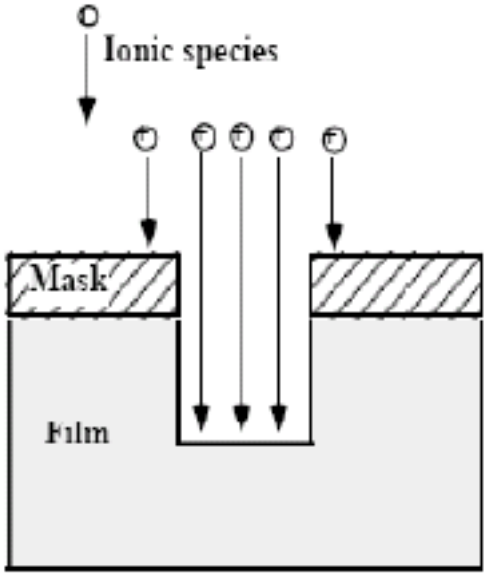
- Chemical removal (etching) dominant
- Very useful for removing organic thin layers (residue, scum)
- Usually uses oxygen plasma (i.e., ozone radicals) to remove film—this is called ashing

Dry Cleaning Example: Barrel Reactor

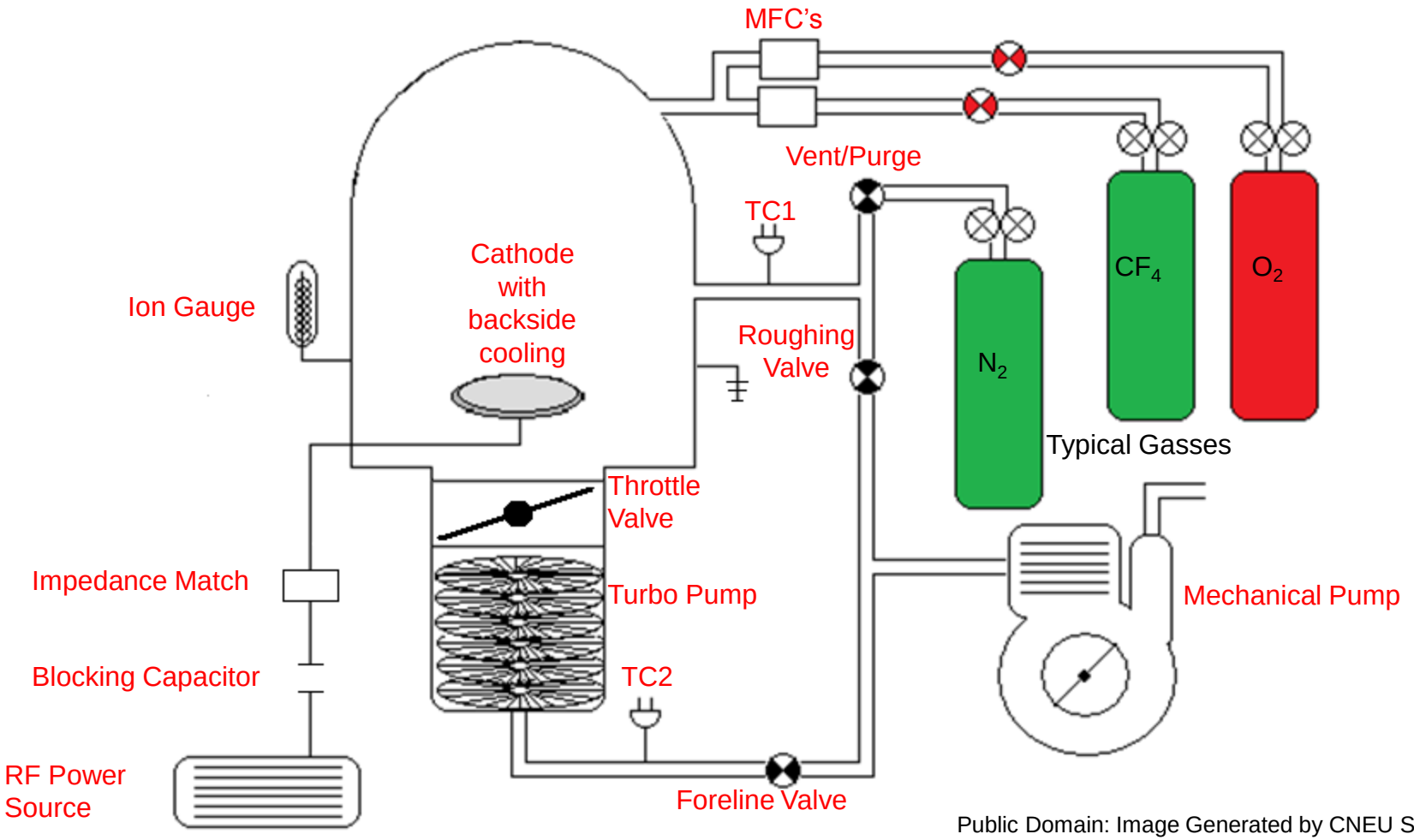


Dry Cleaning Example: Sputter Cleaning

- Purely physical cleaning



Dry Etching Example: Reactive Ion Etch System



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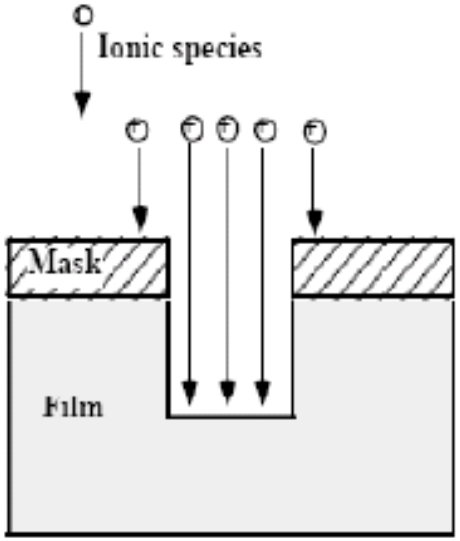
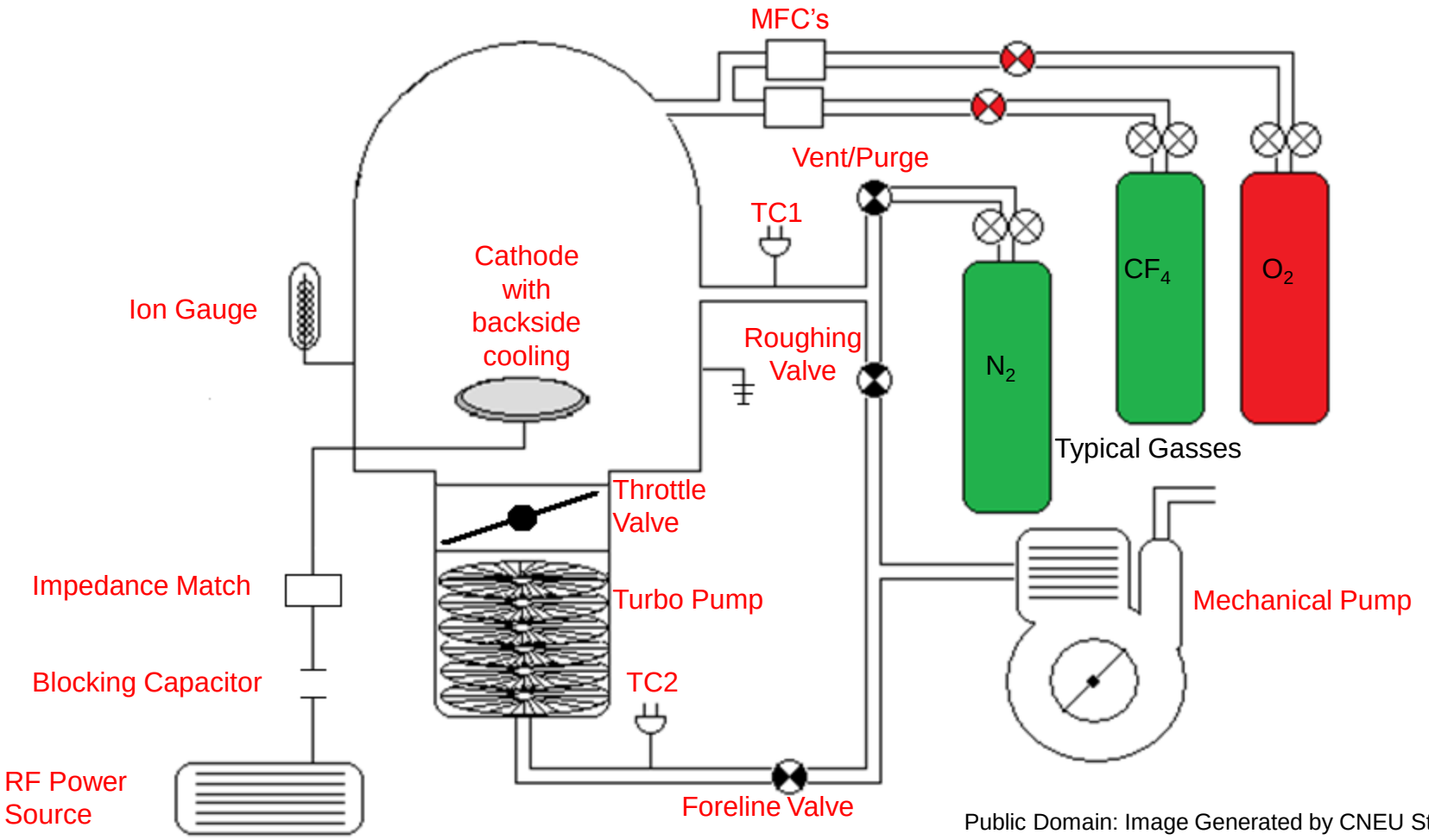
Sputter etching (purely physical)

[Also called ion milling]



Gives anisotropic profile
Not selective
Used when want straight walled profile and selectivity is not an issue
Used for ion milling in chemical analysis

RIE: Playing Physical Bombardment Off Against Chemical Attack



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Summary

- Plasma cleaning and etching processes produce less waste disposal problems
- Effluent control
- Widely used in cleaning applications
- Widely used in etching applications
- RIE gives great versatility in selectivity and etch profile control