THE UNIVERSITY OF TEXAS AT AUSTIN
WHAT STARTS HERE CHANGES THE WORLD

CHE323/CHE384
Chemical Processes for Micro- and Nanofabrication
www.lithoguru.com/scientist/CHE323

Lecture 34
Etch, part 1

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Reading:
Chapter 11, *Fabrication Engineering at the Micro- and Nanoscale*, 4th edition, Campbell

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Etch

- A part of the pattern transfer process, after lithography
- Attributes
  - Etch rate (throughput)
  - Selectivity
  - Directionality/anisotropy
  - Uniformity of the above attributes
  - Defects/cost/safety/environment

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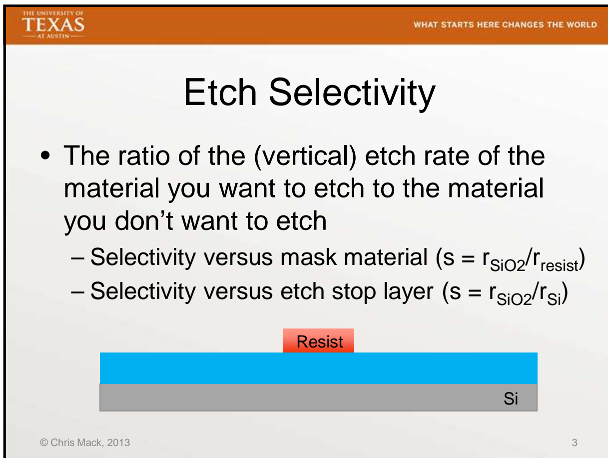
Etch Selectivity

- The ratio of the (vertical) etch rate of the material you want to etch to the material you don't want to etch
  - Selectivity versus mask material ($s = r_{SiO2}/r_{resist}$)
  - Selectivity versus etch stop layer ($s = r_{SiO2}/r_{Si}$)



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Etch Selectivity

- We want high selectivity in general
  - $s > 2$ is OK
  - $s > 4$ is good
  - For some applications, we need higher selectivity
- Selectivity comes through chemistry

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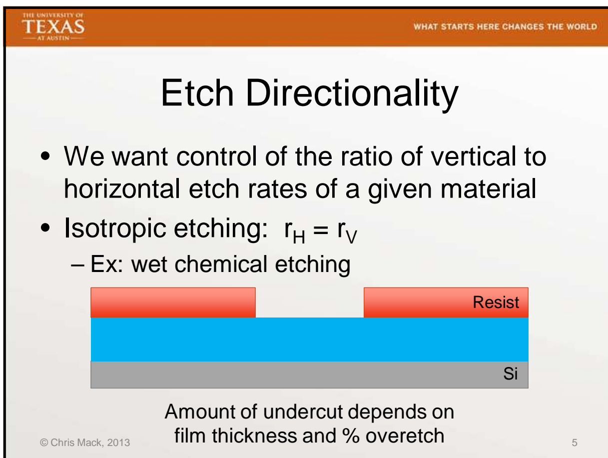
Etch Directionality

- We want control of the ratio of vertical to horizontal etch rates of a given material
- Isotropic etching: $r_H = r_V$
  - Ex: wet chemical etching



Amount of undercut depends on film thickness and % overetch

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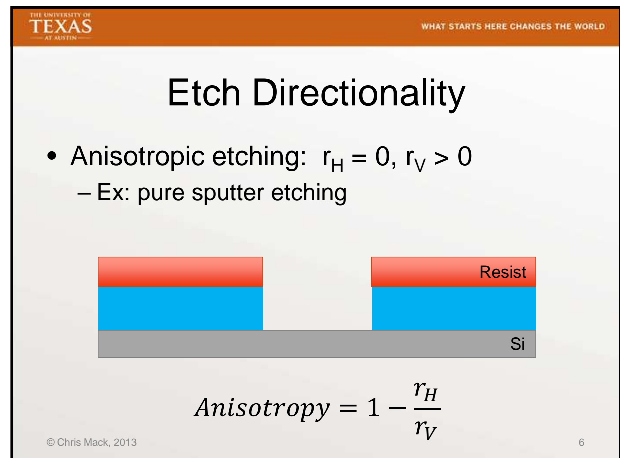
Etch Directionality

- Anisotropic etching: $r_H = 0$, $r_V > 0$
  - Ex: pure sputter etching



$$Anisotropy = 1 - \frac{r_H}{r_V}$$

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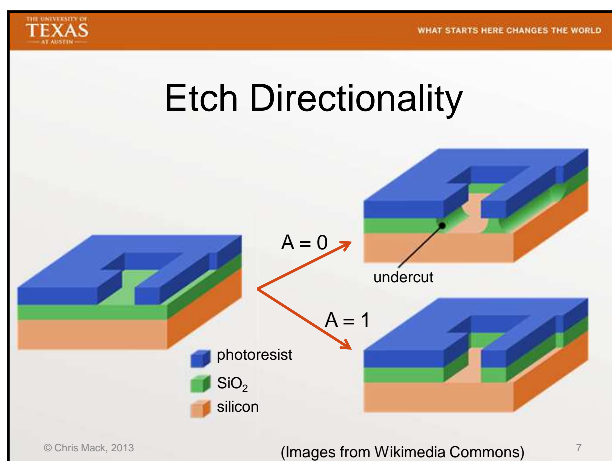
Etch Directionality



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Typical Etch Goals

- High selectivity to etch mask and etch stop layer
- Anisotropy ~ 1
- High etch rates (~ 1 – 10 nm/s)
- It is very hard to get all three!
  - There is often a trade-off between selectivity and anisotropy, and anisotropy and etch rate

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Wet Etch Example

- Buffered HF etching of SiO_2 (buffered oxide etch, BOE)

$$SiO_2 + 6HF \rightarrow H_2SiF_6 + 2H_2O$$

water soluble

- Use NH_4F as a buffer to keep [HF] constant
- Does not etch Si or resist (high selectivity)

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Lecture 34: What have we learned?

- Define etch selectivity
- Define anisotropy
- What common style of etch produces isotropic results?
- What are typical etch goals in semiconductor processing?

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