CHE323/CHE384
Chemical Processes for Micro- and Nanofabrication
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Lecture 23
Sputtering, part 2

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Reading:
Chapter 12, *Fabrication Engineering at the Micro- and Nanoscale*, 4th edition, Campbell

Step Coverage

- Step coverage is good (but not perfect) due to range of incoming angles
- Shadowing still occurs
- Heating wafer increases mobility after sticking
  - Metal grains can form if too hot, increasing roughness
  - Specular reflectivity used to monitor roughness (lower spec limit)

Via Fill Application

Via Fill Application

- To eliminate voids, we want poor step coverage

To Reduce Step Coverage

- Reduce pressure to a few millitorr
  - Mean free path increases to ~1 cm
- Use collimators to direct the sputtered atoms vertically

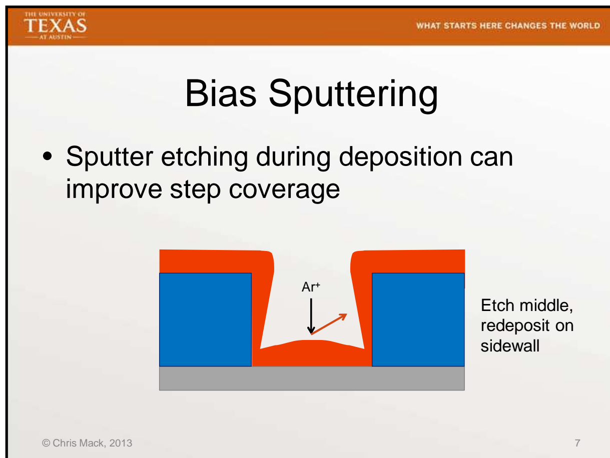
Sputter Cleaning

- If the wafer has a negative bias compared to the plasma, Ar+ will sputter etch the wafer
- This can be used to clean the wafer before deposition begins
  - Can also remove native oxide on silicon
- Problem: can cause damage to substrate

TEXAS
WHAT STARTS HERE CHANGES THE WORLD

Bias Sputtering

- Sputter etching during deposition can improve step coverage



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Example Process

- Aluminum alloy deposition
  - Al + 2% Si + 0.5% Cu
- Planar DC magnetron
  - High deposition rate
  - O_2 and N_2 in chamber must be kept very low

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Stress

- Stress in metal films affects reliability
  - Strain-induced diffusion of grain boundaries
- Thermal mismatch of metal vs. substrate is one cause of stress when deposition is not done at room temperature
- Stress is measured as a change in wafer bow before and after deposition

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Film Quality

- Composition and impurities, stoichiometry
- Electrical and mechanical properties
  - Breakdown voltage, resistivity, stress
- Defects (pinholes, particles)
- Adhesion
- Thickness (accuracy and uniformity)
- Step coverage (planarizing vs. conformal)
- Reflectivity (roughness) and refractive index

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Lecture 23: What have we learned?

- How is step coverage controlled in sputter deposition systems?
- What step coverage is needed for the via fill application?
- What causes stress in deposited films, and how is it measured?
- How many aspects of film quality can you name?

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