EE 527 MICROFABRICATION

Lecture 3

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PROCESSES

- High-temperature steps are used to oxidize silicon and to dope silicon by diffusion.
  - High temperatures are from 900°C to 1200°C
- Low-temperature processes leave metal-to-silicon interface stable.
  - 450°C is the upper limit for low temperatures.
- High-temperature regime is also known as the front-end of the line (FEOL) in the silicon IC.
- Low-temperature regime is also known as the back-end of the line (BEOL) in the silicon IC.

High temperature, deposition, patterning and etching, bonding

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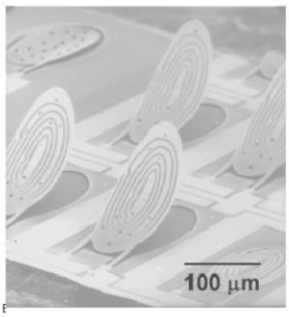
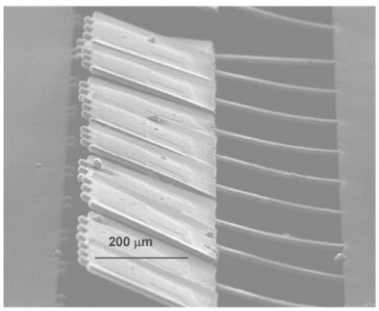
PROCESSES/THIN FILMS

- More functionality is built on the substrates by deposition of thin films.
  - Various conducting, semiconducting, insulating, transparent, superconducting, catalytic, piezoelectric and other layers.
- A special case of thin-film deposition is epitaxy.
  - The deposited film registers the crystalline structure of the underlying substrates.
- Interface: stability of interfaces is important.
  - Heat treatments during the fabrication would induce chemical reactions and diffusion.
  - Some reactions are desired but most should be prevented.
- High Stresses between substrates and thin films will curve the substrates.

INTRINSIC STRESS

- The intrinsic stress: the stress is experienced by thin film materials under room temperature and zero loading conditions.
- The intrinsic stress can cause deformation-damages in excessive cases.





THIN FILM DEPOSITION

Formation of films on surface of substrate

- Structural layers
- Device layers
- Sacrificial layers

Wide variety of techniques:

- CVD, PECVD
- Evaporation
- Sputtering
- Epitaxial growth
- Oxidation of Si

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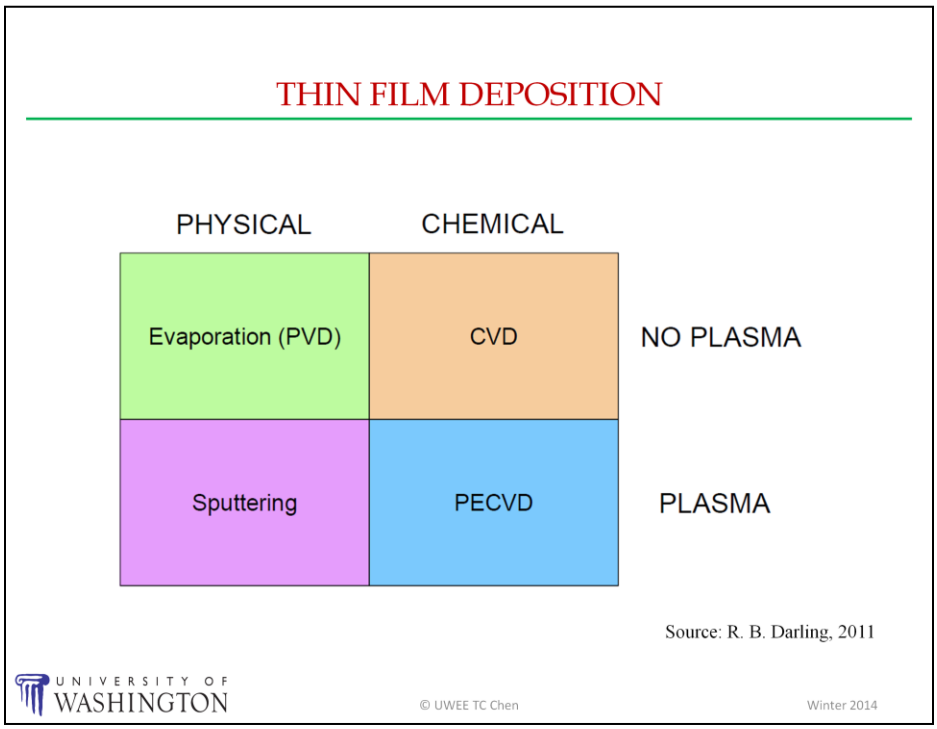

Source of the films: physical and chemical

Energy of film formation: thermal and others

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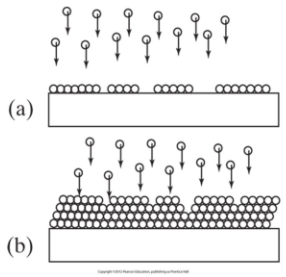
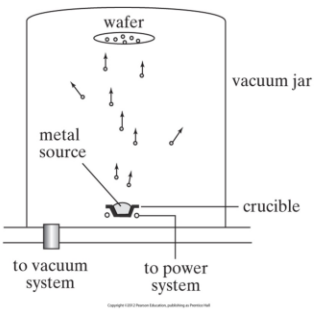
THIN FILM DEPOSITION



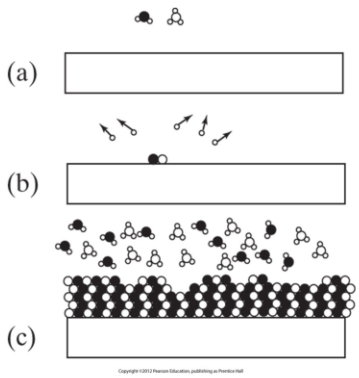
A process of evaporating a thin film.



A schematic diagram of the metal evaporation equipment.

Direct transfer of the material from a source to the wafer surface in an atom-by-atom, layer-by-layer fashion.
Thermal evaporation deposition and sputtering are the common examples.

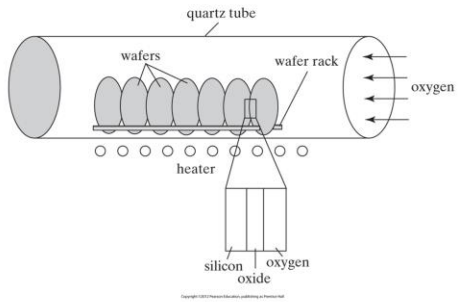
THIN FILM DEPOSITION



- A second method for placing thin film materials on a wafer surface is chemical vapor deposition.
- Two or more active species arrive at the vicinity of the wafer surface, react, and produce a solid phase on the surface of the wafer.

A process of chemical reactive deposition (e.g., chemical vapor deposition).

THERMAL OXIDATION OF SILICON



- Normal operation temperature: 900°C and above
- As the thickness of oxide grows, the rate of oxidation growth decreases.

PROCESSES/PATTERNING

- Patterning processes define structures usually in two steps,
  - Polymer processing to form an intermediate pattern which then acts as a mask for etching, deposition, ion implantation.
  - After the pattern has been transferred to solid materials, the intermittent polymer mask is removed.

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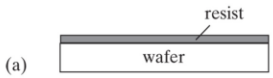
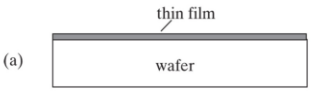
PHOTOLITHOGRAPHY



Process flow for patterning photoresist with a photomask.



Process of lithographically patterning a thin film using the photoresist as a mask.

Add slides for etching and bonding

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