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EE C247B - ME C218 Introduction to MEMS Design Spring 2018

Prof. Clark T.-C. Nguyen

Dept. of Electrical Engineering & Computer Sciences
University of California at Berkeley
Berkeley, CA 94720

Lecture Module 3: Oxidation & Film Deposition

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Lecture Outline

- Reading: Senturia, Chpt. 3; Jaeger, Chpt. 2, 3, 6
 - ↳ Example MEMS fabrication processes
 - ↳ Oxidation
 - ↳ Film Deposition
 - Evaporation
 - Sputter deposition
 - Chemical vapor deposition (CVD)
 - Plasma enhanced chemical vapor deposition (PECVD)
 - Epitaxy
 - Atomic layer deposition (ALD)
 - Electroplating

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MEMS Fabrication

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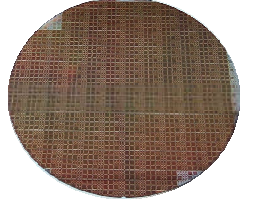
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Making Mechanical Devices

- How best does one make a mechanical product?
- Assembly line production?
 - ↳ Pick and place parts
 - ↳ Used for many macroscopic mechanical products
 - ↳ Robotic automation greatly reduces cost
- **Problem:** difficult to do this with MEMS-scale parts (but not impossible, as we'll soon see ...)
- **Solution:** borrow from integrated circuit (IC) transistor technology
 - ↳ Use monolithic wafer-level fabrication methods
 - ↳ Harness IC's batch methods, where multiple devices are achieved all at once



Automobile Assembly Line



CMOS Integrated Circuit Wafer

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Polysilicon Surface-Micromachining

The diagram illustrates the polysilicon surface-micromachining process in three stages. The top cross-section shows a Silicon Substrate with a thin layer of Nitride, followed by a thick layer of Isolation Oxide. On top of the isolation oxide, there are layers of Interconnect Polysilicon, Sacrificial Oxide, and Structural Polysilicon. The middle cross-section shows the wafer being etched with Hydrofluoric Acid Release Etchant, which is selectively removing the sacrificial oxide layer. The bottom cross-section shows the final Free-Standing Polysilicon Beam structure. To the right, a photograph shows a 300 kHz Folded-Beam Micromechanical Resonator.

- Uses IC fabrication instrumentation exclusively
- *Variations*: sacrificial layer thickness, fine- vs. large-grained polysilicon, *in situ* vs. $POCl_3$ -doping

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