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# EE C247B - ME C218 Introduction to MEMS Design Spring 2016

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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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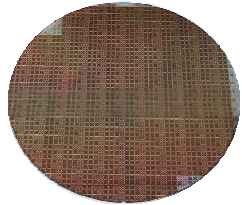
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## Making Mechanical Devices

- 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

- Uses IC fabrication instrumentation exclusively
- **Variations:** sacrificial layer thickness, fine- vs. large-grained polysilicon, *in situ* vs. POCL<sub>3</sub>-doping

300 kHz Folded-Beam Micromechanical Resonator

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### Electroplating: Metal MEMS

- Use electroplating to obtain metal structures
- When thick: call it "LIGA"
- **Pros:** fast low temp deposition, very conductive
- **Cons:** drift, low mech. Q but may be solvable?

RF Switch

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### Bulk Micromachining and Bonding

- Use the wafer itself as the structural material
- **Adv:** very large aspect ratios, thick structures
- **Example:** deep etching and wafer bonding

Micromechanical Vibrating Ring Gyroscope  
1 mm  
[Najafi, Michigan]

Microrotor (for a microengine)  
[Pisano, UC Berkeley]

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