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EE C247B - ME C218 Introduction to MEMS Design Spring 2015

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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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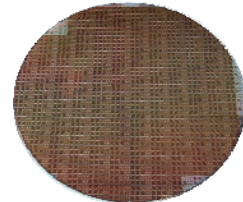
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Making Mechanical Devices

- 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

The diagram illustrates the polysilicon surface-micromachining process in three stages. The top stage shows a cross-section of a silicon substrate with a thin layer of nitride, followed by a layer of isolation oxide. On top of the isolation oxide, there is a layer of interconnect polysilicon, a layer of sacrificial oxide, and a top layer of structural polysilicon. The middle stage shows the wafer being etched with hydrofluoric acid release etchant, which removes the sacrificial oxide layer. The bottom stage shows the final product: a free-standing polysilicon beam on a silicon substrate. To the right of the diagram is a photograph of 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

300 kHz Folded-Beam Micromechanical Resonator

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