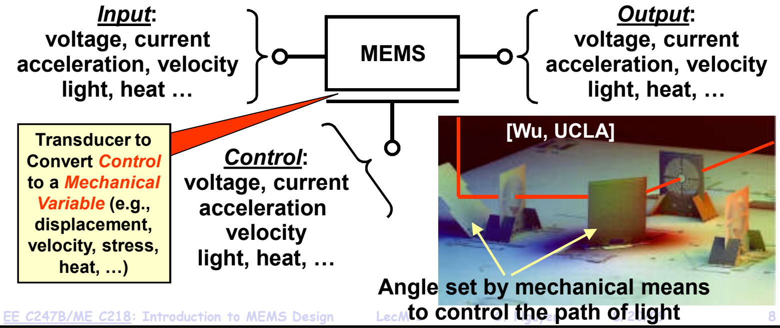
Lecture Outline

- Reading: Senturia, Chapter 1
- Lecture Topics:
  - Definitions for MEMS
  - MEMS roadmap
  - Benefits of Miniaturization

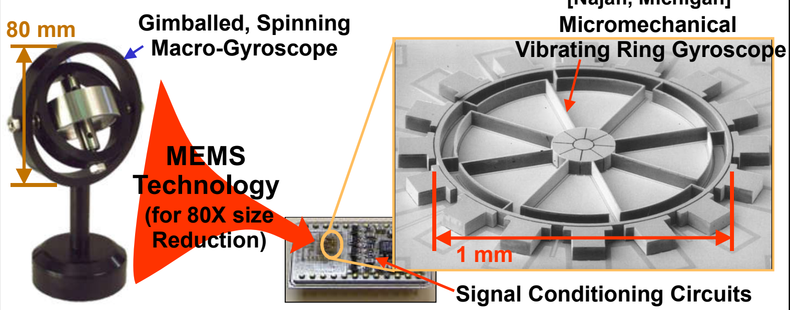
MEMS: Micro Electro Mechanical System

- A device constructed using micromachining (MEMS) tech.
- A micro-scale or smaller device/system that operates mainly via a mechanical or electromechanical means
- At least some of the signals flowing through a MEMS device are best described in terms of mechanical variables, e.g., displacement, velocity, acceleration, temperature, flow



Other Common Attributes of MEMS

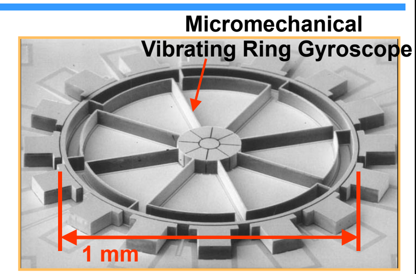
- Feature sizes measured in microns or less



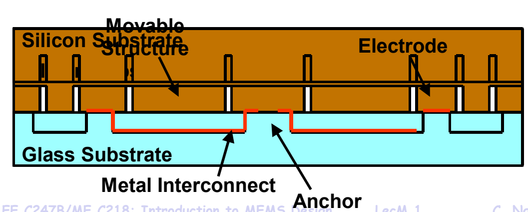
- Merges computation with sensing and actuation to change the way we perceive and control the physical world
- Planar lithographic technology often used for fabrication
  - can use fab equipment identical to those needed for IC's
  - however, some fabrication steps transcend those of conventional IC processing

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

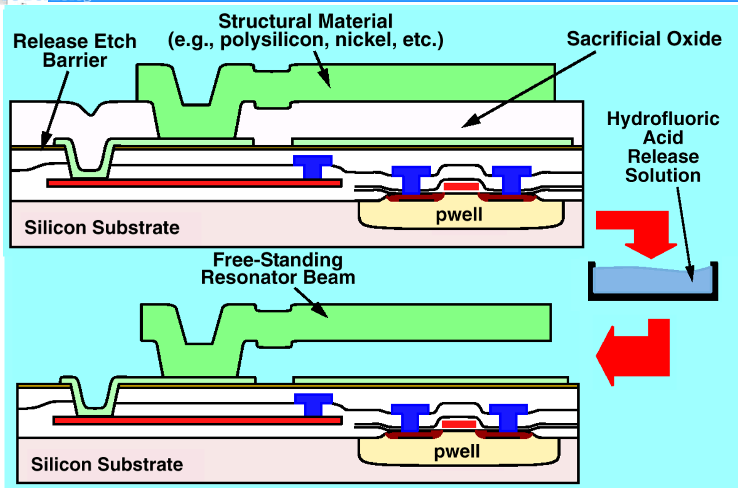


[Najafi, Michigan]



Microrotor
(for a microengine)

Surface Micromachining



- Fabrication steps compatible with planar IC processing

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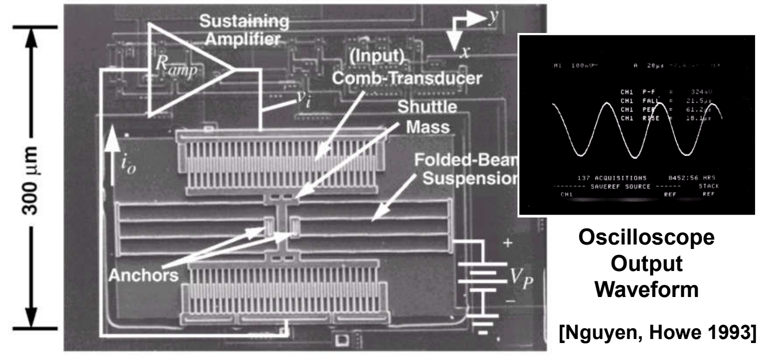
Single-Chip Ckt/MEMS Integration

- Completely monolithic, low phase noise, high-Q oscillator (effectively, an integrated crystal oscillator)



- To allow the use of >600°C processing temperatures, tungsten (instead of aluminum) is used for metallization

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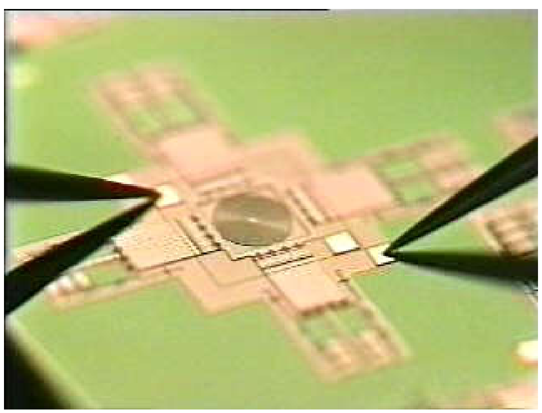
3D Direct-Assembled Tunable L



[Ming Wu, UCLA]

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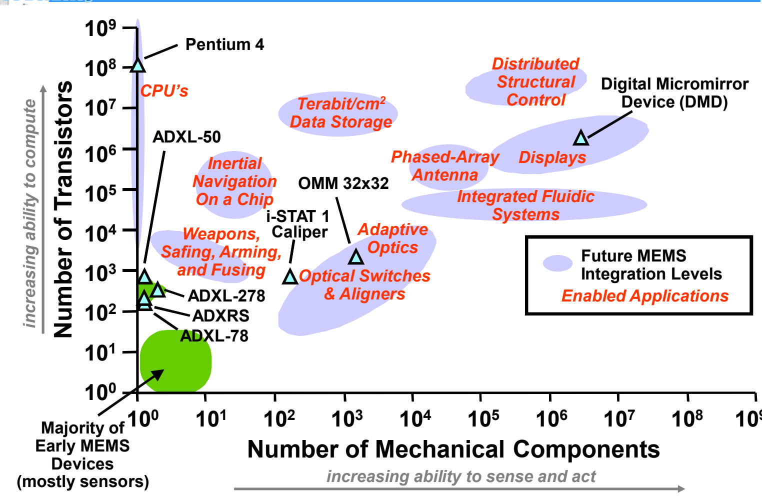
Technology Trend and Roadmap for MEMS



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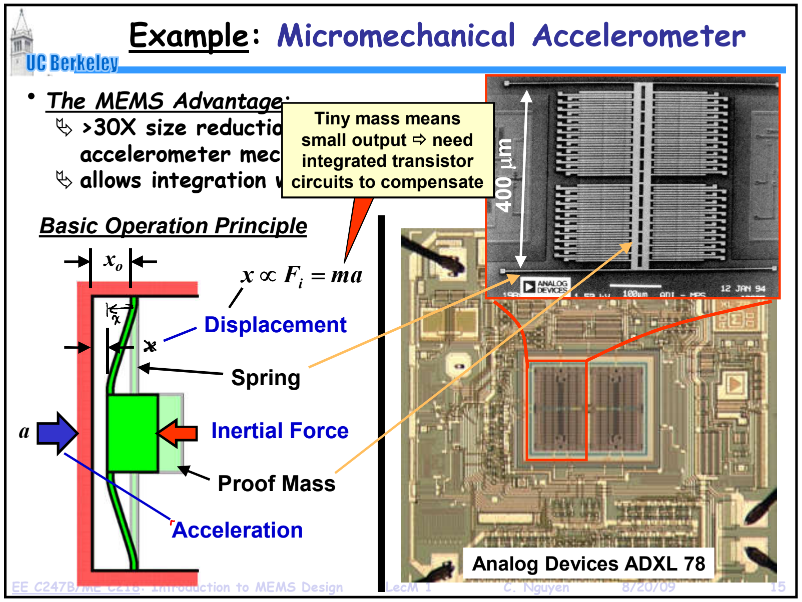

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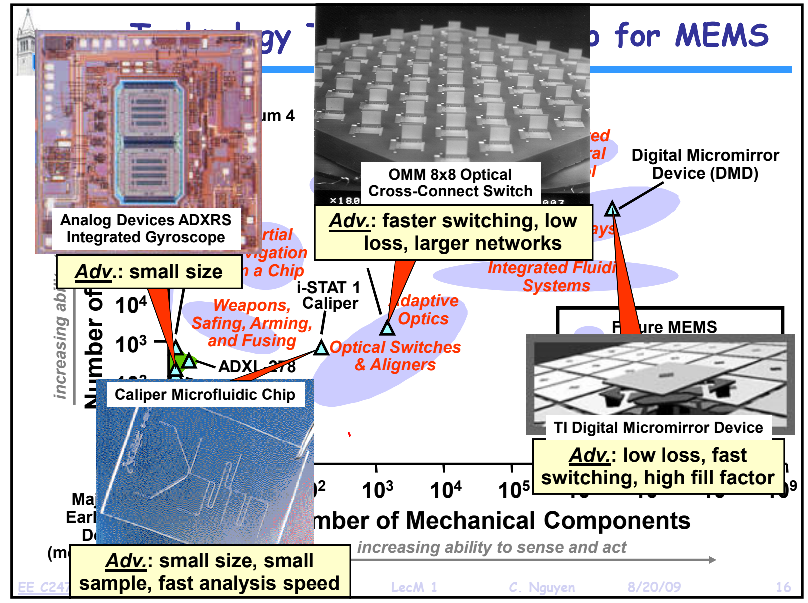

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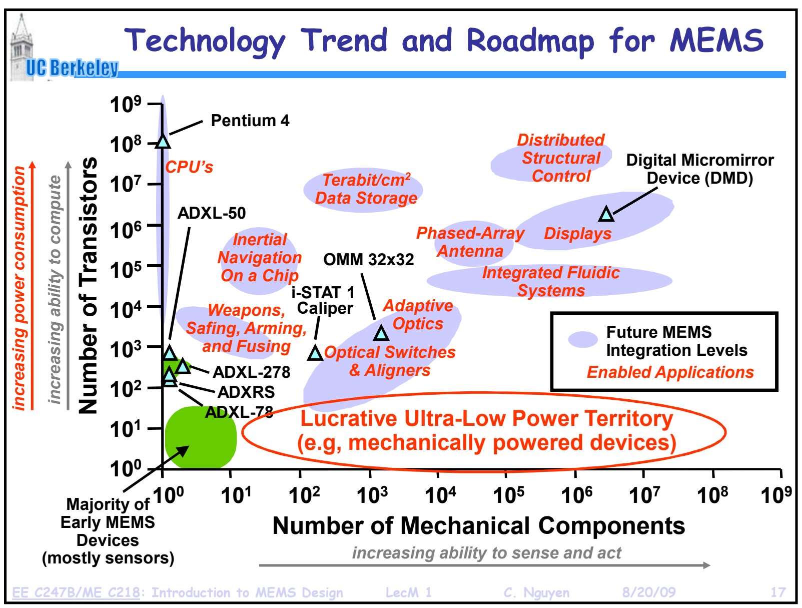

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Benefits of Size Reduction: MEMS

UC Berkeley

- Benefits of size reduction clear for IC's in elect. domain
  - size reduction ⇨ speed, low power, complexity, economy
- MEMS: enables a similar concept, but …

MEMS extends the benefits of size reduction *beyond* the electrical domain

Performance enhancements for application domains beyond those satisfied by electronics in the same general categories

Speed ⇨ Frequency ↑, Thermal Time Const. ↓
Power Consumption ⇨ Actuation Energy ↓, Heating Power ↓
Complexity ⇨ Integration Density ↑, Functionality ↑
Economy ⇨ Batch Fab. Pot. ↑ (esp. for packaging)
Robustness ⇨ g-Force Resilience ↑

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