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OBJECTIVE

- What is MEMS Technology?
- MEMS Applications
- Accelerometer
  - Functionality
  - Fabrication
  - Applications
  - Current State
  - Future trends
- Conclusion
WHAT IS MEMS TECHNOLOGY?

- **Micro-Electro-Mechanical Systems**
- **Definition:** integration of mechanical elements, sensors, actuators, & electronics on a Si substrate through micro-fabrication technology
- $10^{-6} \sim 10^{-3}$ m
- Electronics fabricated using IC processing
- Micromechanical components fabricated using “micro-machining” processes
  - Selective etching
  - Multi-layered structures
Applications of MEMS

- Biotechnology
  - New discoveries:
    - Micro-machined canning Tunneling Microscopes
    - Biochips – detection of chemical/biological agents
    - Microsystems for high-throughput drug screening

- Communications
  - Beneficial of high frequency circuits
    - Improve performance
    - $A_{\text{circuit}}$, $P_{\text{consumption}}$, cost

- MEMS Accelerometers
  - Replace conventional accelerometers – crash air-bag deployment systems
    - Integrate accelerometer & electronics onto a single chip
      - Costs ~10 times less than conventional accelerometers
      - Smaller, more functional, lighter, more reliable

- Other applications: pressure, chemical and flow sensors, micro-optics, optical scanners, fluid pumps, ink-jet printers
ACCELEROMETER: HOW IT WORKS

- The fingers move in response to acceleration
- Change in spacing between the fingers can be measured as a capacitance change
- Same chip also contains signal processing & self-testing capability
ACCELEROMETER: HOW IT IS FABRICATED

- Metal is electroplated
- Suspended sensed elements
- Sacrificial layer
- Complex multi-layered structures
- ASIC (application specific IC)
- Transduction
- Transducer generates a pulse stream
ACCELEROMETER: HOW IT IS PACKAGED

- Standard low cost plastic injection-molded package
- For stress reduction: Si gel is spread
- 2-D & 3-D packaging w/ 2 or 3 sensors in preparation

Figure 5: Top view of a decapsulated sensor within SOIC 16 plastic package.
Current Applications:
- Monitor vibration level
- Monitor & predict health & condition of moving machinery
- Record earthquake data
- Navigation
- Anti-theft
- Loudspeaker design
- Joysticks
- Athletic training equipment
- Auto shut-off valves for gas & water mains
WHAT’S IN STORE FOR MEMS?

- Dual & tri-axial devices on a single IC
- Decrease in cost
- Gyroscopic devices
- Magnetic sensors
- Multi-sensor chips
- Grow up to $68 B by year 2005
- bioMEMS
- rf MEMS
- Optical networks
- Micro-mirrors

“DNA chip”: biomolecules on electronic devices

[Image: DNA chip diagram]

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