Advanced Sensing Techniques

Lecture Material 3

Few references:

1. Fundamentals of Microfabrication by Marc Madou
2. Micro and Smart systems: G . K. Ananthsuresh et al.
3. Couple of Internet sources for Image illustration

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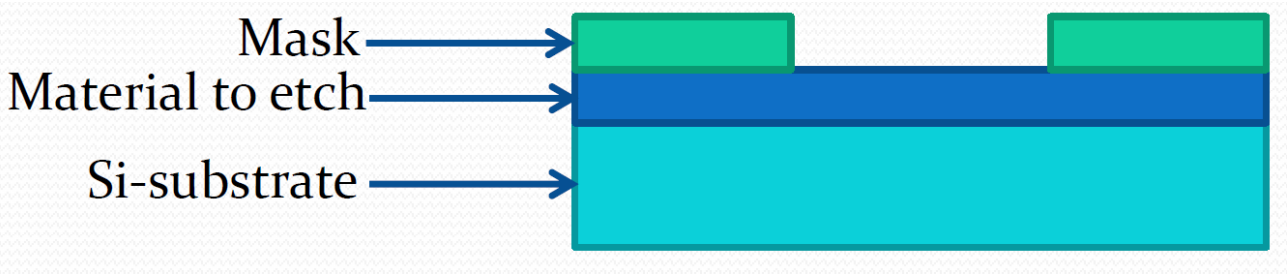
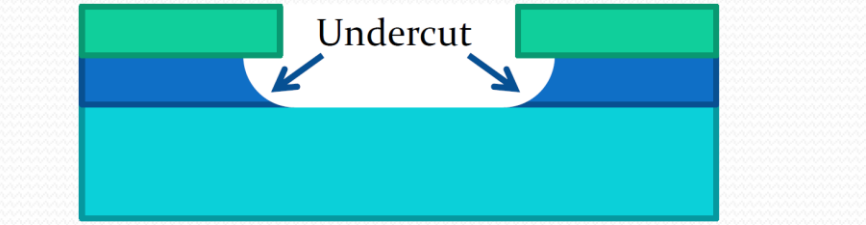
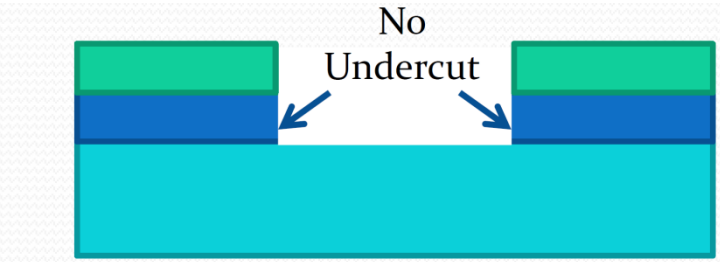
Etching

- Etch: removal of material from wafer (e.g. removal silicon dioxide)
- Isotropic vs. Anisotropic
  - Isotropic– etch rate is same in all directions
  - Anisotropic– etch rate is orientation dependent





Isotropic: etches equally in all directions



Anisotropic: etches at different rates in different directions

Wet Etching

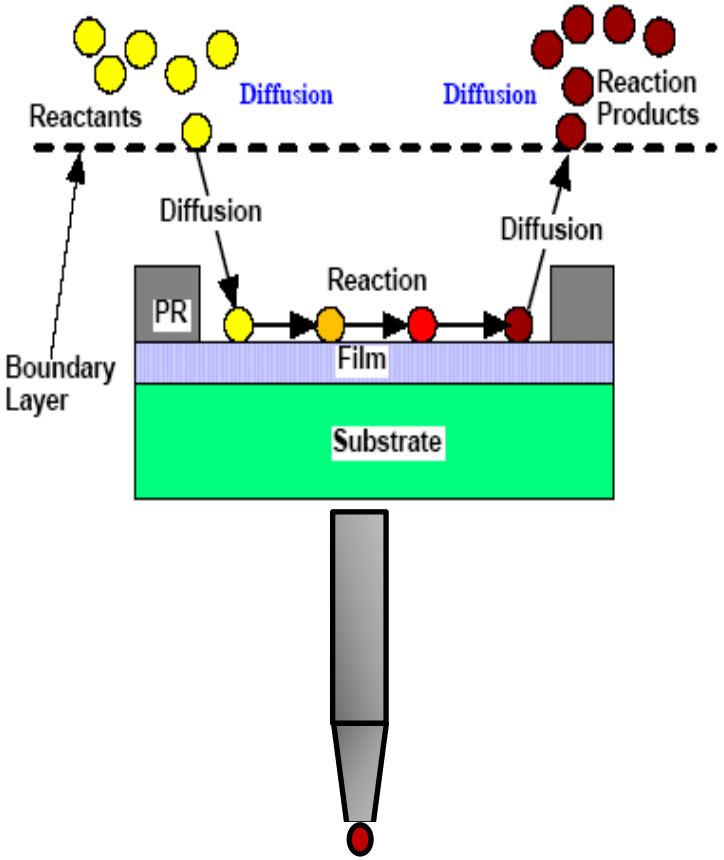
- Sample is kept in etchant solution for specified amount of time
- Sample is removed from solution
- Sample is rinsed in deionized water and dried

Example Mechanism: e.g. Etchant HF, HNO3 to remove Si

hole injection: $HNO_3 + H_2O + HNO_2 \rightarrow 2HNO_2 + 2OH^-$

oxidation: $Si^{4+} + 4OH^- \rightarrow SiO_2 + H_2$

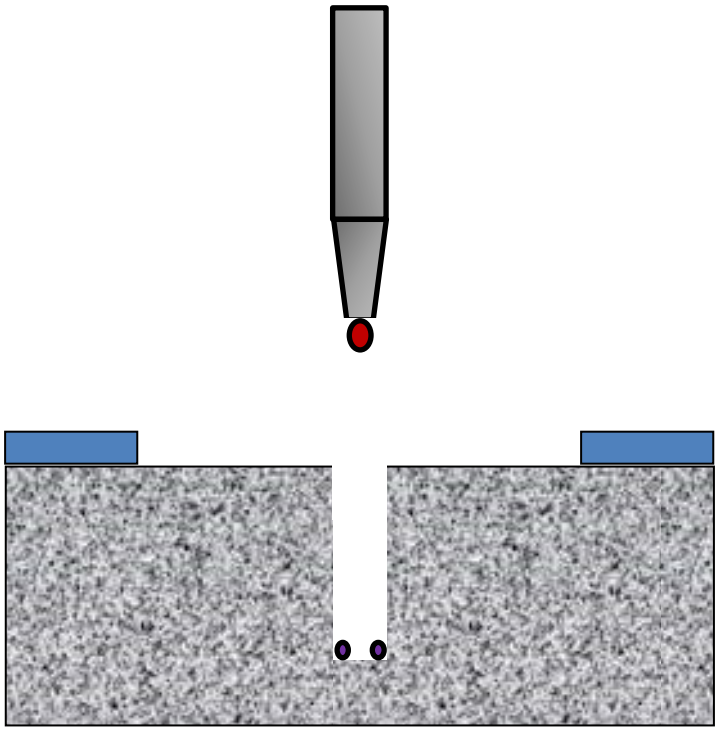
oxide removal: $SiO_2 + 6HF \rightarrow H_2\,SiF_6$



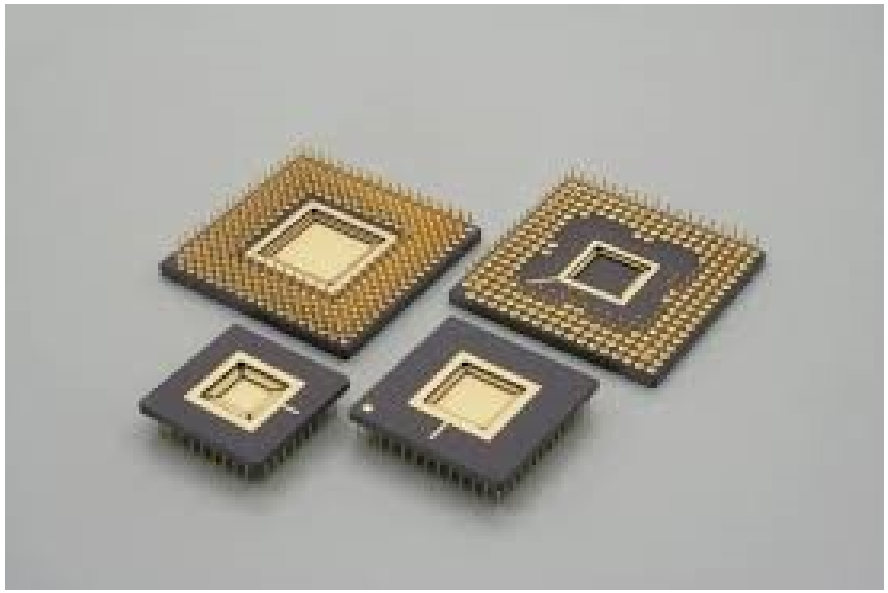
Dry Etching

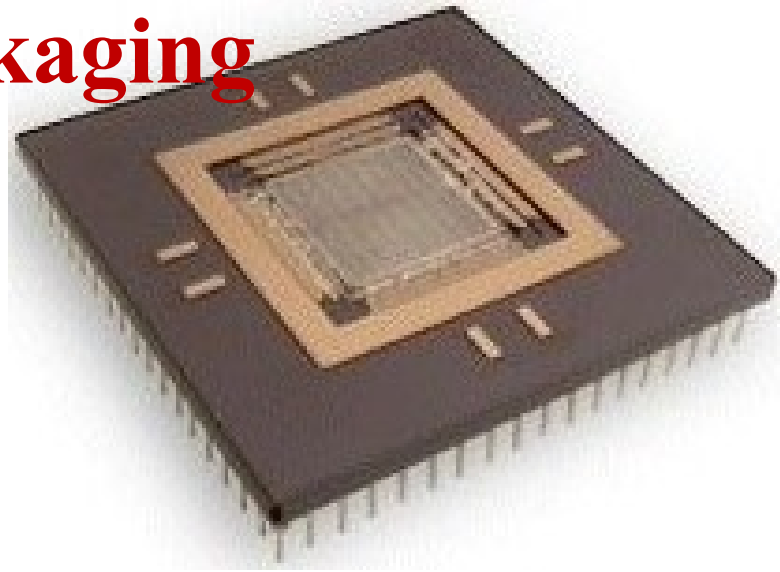
- Etchant is in gas form
- Physical & Chemical mechanism:
  - Removal based on impact ,momentum transfer and chemical reaction;
  - Good material selectivity, directional control and high etch rate

Example: Etchant Cl_2, CCl_2, F_2 **to remove Si**

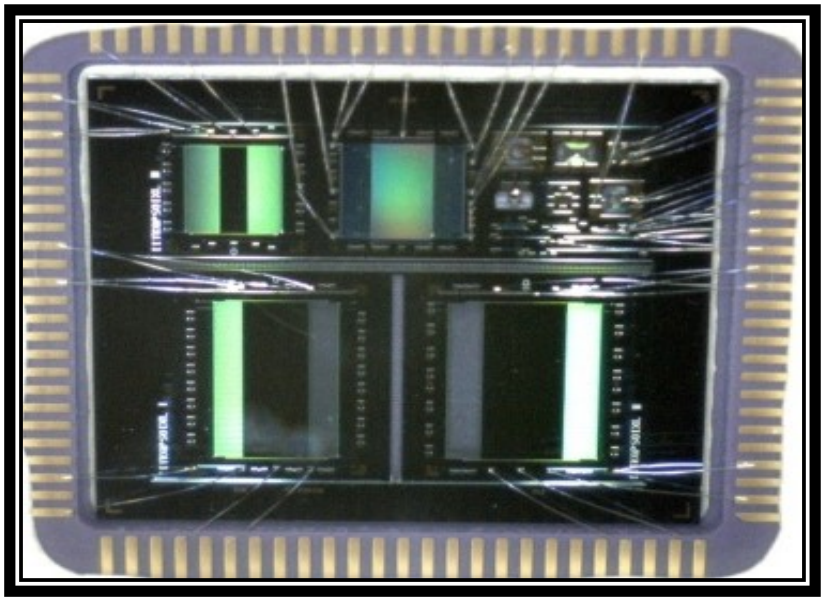


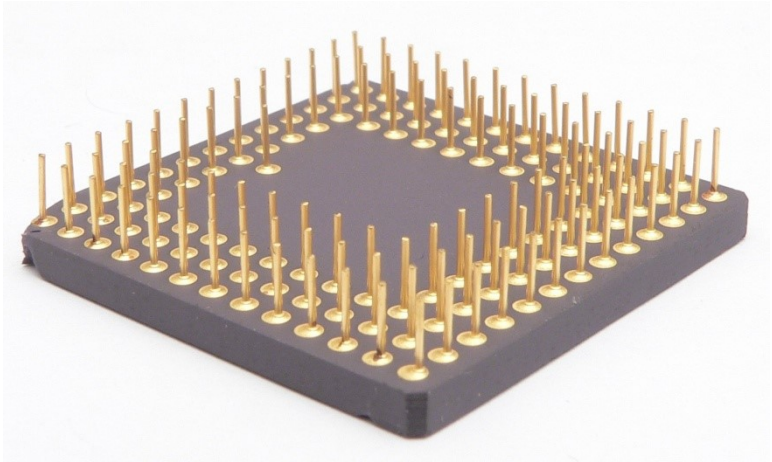
Wire Bonding and Packaging





Packaging of MEMS at SCL, Chandigarh

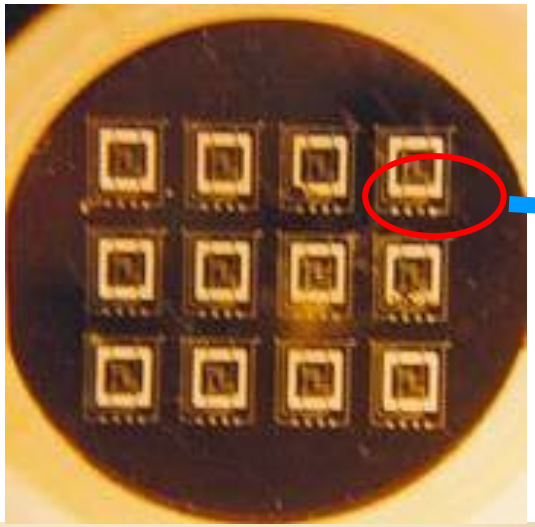


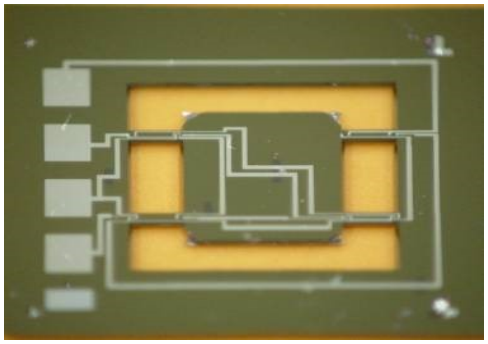


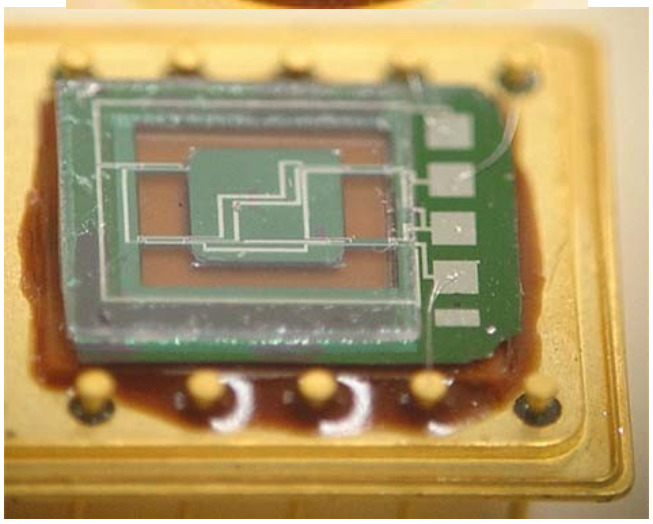
PGA: Pin Grid Array (100 pin here)

Example: PIEZORESISTIVE SILICON ACCELEROMETER

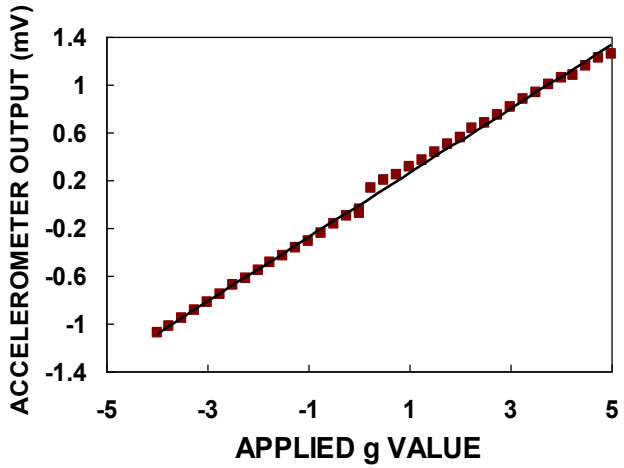
Microphotograph of fabricated accelerometer







Packaged accelerometer device



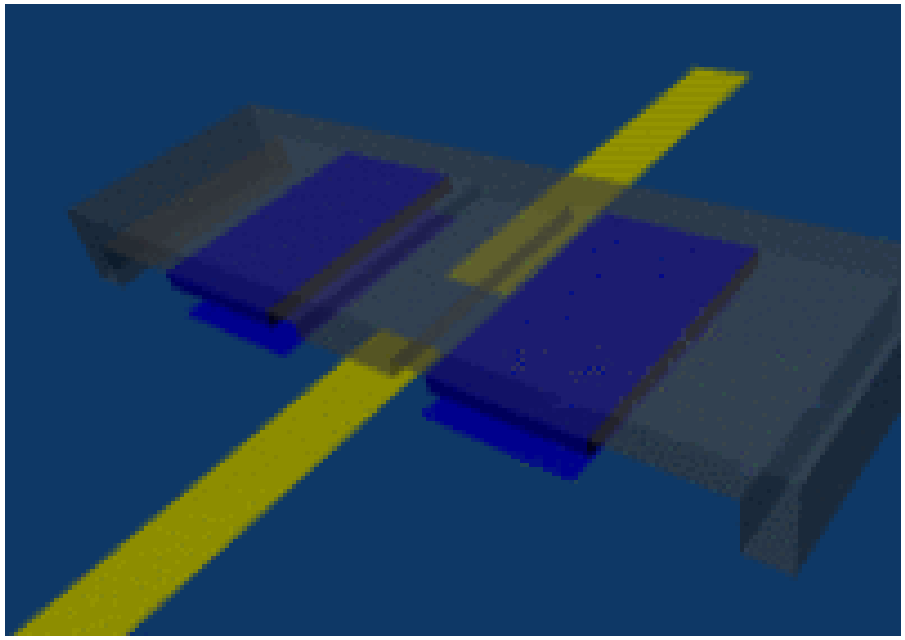
Accelerometer performance tested at ADE, Bangalore

	Z-axis	X axis	Y axis
Sensitivity (µV/g):	570	30	26
Linearity (%of FS):	0.19	1.5	0.63

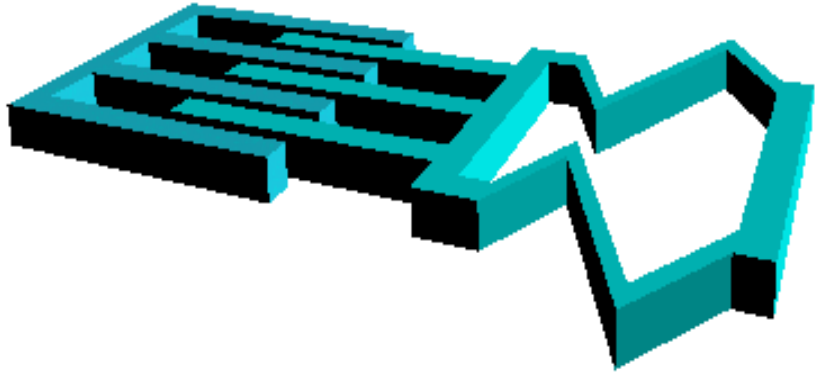
Testing

Sensing and Actuation Methods

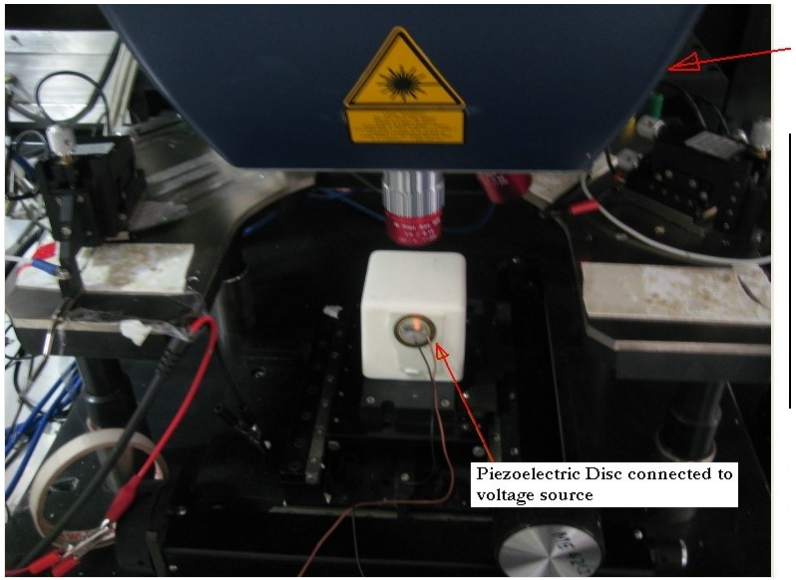
- Electrostatic (Preferable)
- Piezoelectric
- Thermal
- Magnetic etc.

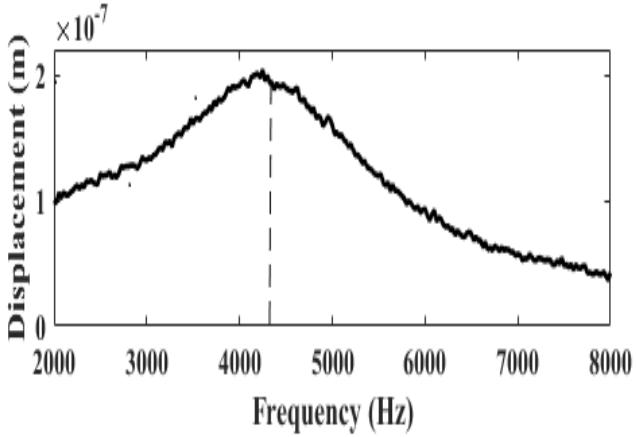


- **Advantages of ES method:**
  - ✓Less resource requirement
  - ✓CMOS integration compatibility
  - ✓Large force generation
  - ✓Scalability etc.



Popular Testing Equipment





Completion of Microfabrication Process Cycle