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FACULTY OF ENGINEERING AND TECHNOLOGY

MEMS-035

Lecture -02

FABRICATION METHODS

BULK MICROMACHINING:

- oldest micromachining technology
- technique involves selective removal of substrate to produce mechanical components
- accomplished by physical or chemical process with chemical being used more for MEMS production
- chemical wet etching is popular because of high etch rate and selectivity
- isotropic wet etching: etch rate not dependent on crystallographic orientation of substrate and etching moves at equal rates in all directions
- anisotropic wet etching: etch rate is dependent on crystallographic orientation of substrate

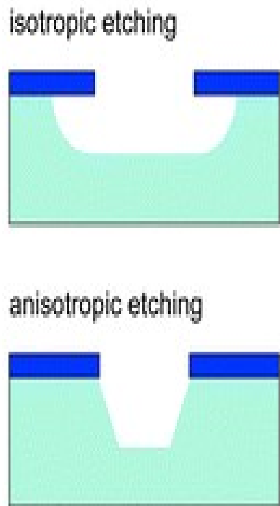
Surface Micromachining:

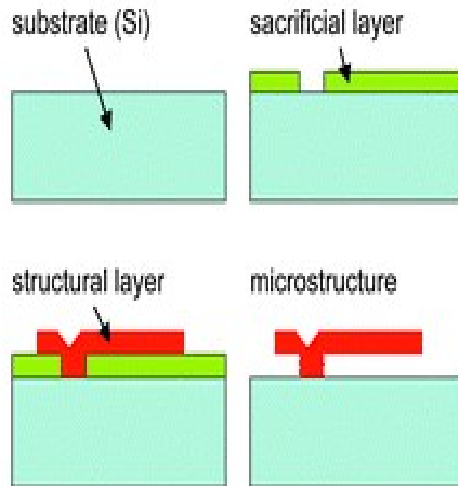
- Process starts with deposition of thin-film that acts as a temporary mechanical layer (sacrificial layer)
- Device layers are constructed on top
- Deposition and patterning of structural layer
- Removal of temporary layer to allow movement of structural layer

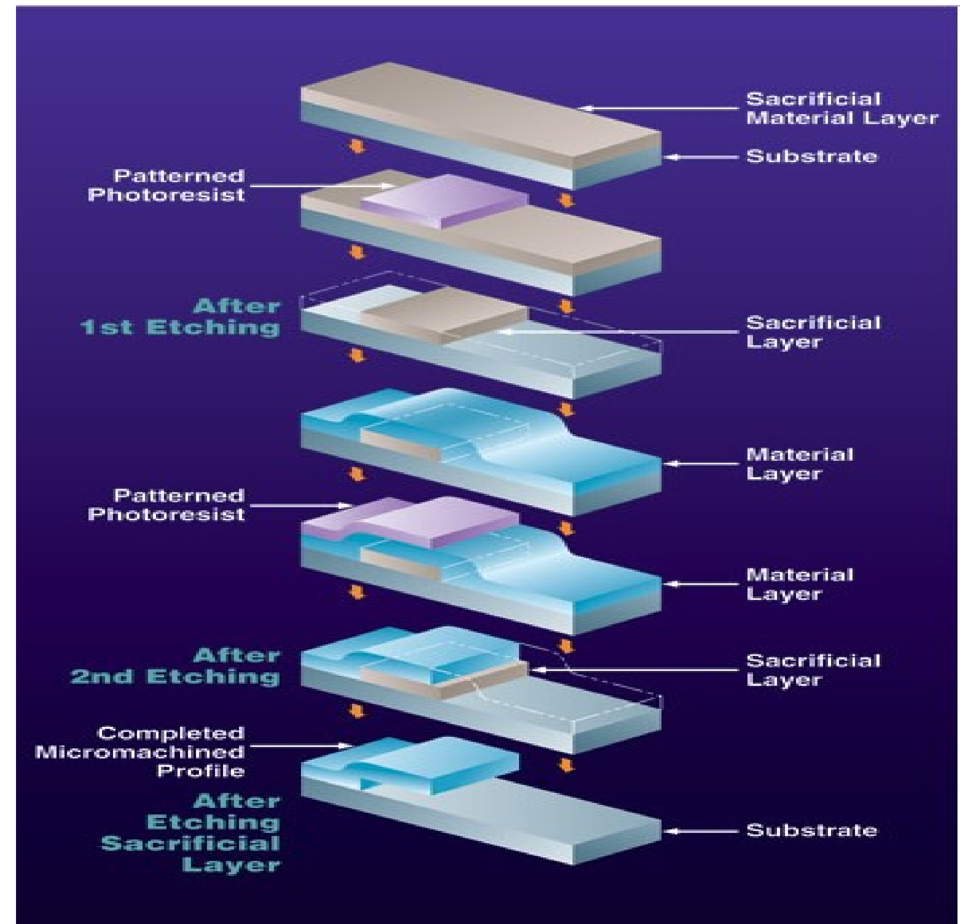
BENEFITS: variety of structure, sacrificial and etchant combinations, uses single-sided wafer processing allows higher integration density and lower resultant per die cost compared to bulk micromachining

DISADVANTAGES: mechanical properties of most thin-films are usually unknown and reproducibility of their mechanical properties

a. bulk micromachining   b. surface micromachining

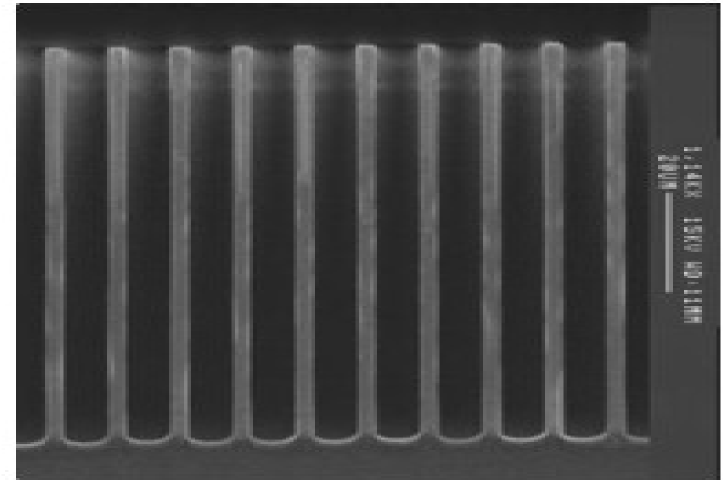






WAFER BONDING

- Method that involves joining two or more wafers together to create a wafer stack
- Three types of wafer bonding: direct bonding, anodic bonding, and intermediate layer bonding
- All require substrates that are flat, smooth, and clean in order to be efficient and successful



cross section of a silicon wafer demonstrating trenches that can be fabricated using DRIE tech

HIGH ASPECT RATIO FABRICATION (SILICON)

- Deep reactive ion etching (DRIE)
- Enables very high aspect ratio etches to be performed into silicon substrates
- Sidewalls of the etched holes are nearly vertical
- Depth of the etch can be hundreds or even thousands of microns into the silicon substrate.

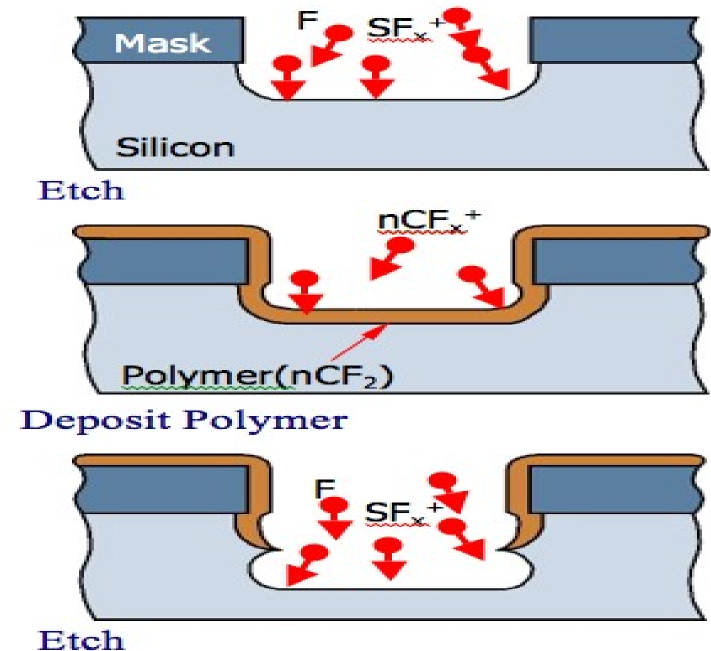


Figure 7: Illustration of how deep reactive ion etching works.

MEMS DEVICES USED IN SPACE EXPLORATION FIELD INCLUDE:

1. Accelerometers and gyroscopes for inertial navigation
2. Pressure sensors
3. RF switches and tunable filters for communication
4. Tunable mirror arrays for adaptive optics
5. Micro-power sources and turbines
6. Propulsion and attitude control
7. Bio-reactors and Bio-sensors, Micro-fluidics
8. Thermal control
9. Atomic clocks

Thank You