Introduction to Microfabrication

Fabrication processes used to fabricate integrated circuits and most MEMS devices

For a more detailed study of microfabrication:

(1) ELEC 5730/6730 Microelectronic Fabrication

(2) ELEC 5820/6820 MEMS

Micromachining: A term used to describe the process of fabricating MEMS or micromachined devices

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Silicon (Si)

The base material for microfabrication: Substrate

Si is the most common substrate material

Si: hard, brittle semiconductor material

Single crystal Si is grown into ingots and sawn/polished to make thin wafers – used as substrates

(1) Example Si wafer: 100mm diameter and 500µm thick

(2) Diamond crystal structure, different crystalline planes: (100), (110), (111): with different properties

(3) Can be doped n- or p-type: can be high or low resistivity

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Other Materials in Si Based MEMS:

(1) SiO₂: grown onto exposed Si though a process called oxidation

Typically less than 1µm thick

(2) Polysilicon: polycrystalline Si deposited onto a substrate
Up to a few µm thick
(3) Metallization: deposited layers of “films” of metal (Al, Ti, Au, Cr…)
   Thin films: up to few µm thick
   Thick films: greater thicknesses (up to 100s of µm thick)
(4) Non-metallic layers
   Silicon nitride (SiN)
   Polymers for various applications
   Diamond coatings
   Epoxies

Materials in Non-Si Based MEMS:

(1) SiC (silicon carbide)
(2) Diamond
(3) Glasses
(4) Ceramics
(5) Polymers
(6) PCB laminates
(7) Metals

Processing Types:

Additive Process: The deposition of a layer or volume of a material
(1) spin coating
(2) thermal oxidation (Si + O₂ + heat → SiO₂)
(3) vapor deposition (LPCVD, PECVD, etc.)
(4) sputtering
(5) evaporation (thermal or electron beam)
(6) atomic layer deposition (ALD)
(7) electroplating
(8) electroless plating
(9) screen printing
(10) lamination
(11) 3D printing

**Subtractive Process:** The removal of material
(1) mechanical drilling or milling
(2) laser drilling/cutting
(3) grinding and polishing
(4) ion milling/FIB
(5) wet etching (acids, bases or solvents to remove exposed material): solid→liquid
(6) dry etching (gas or plasma to remove exposed material): solid→gas
(7) Electrical discharge machining (EDM)
(8) Embossing (sort of like a subtractive process)