

Core Paper

EL- 801: Semiconductor fabrication & Characterization Total Periods: 48

Unit-1 (P-15)
Introduction of Semiconductor Process Technology, Semiconductor materials, single crystal, polycrystalline and amorphous, Crystal growth techniques: Si from the Czochralski technique, starting material, Distribution of dopants, Effective Segregation Coefficient. Silicon Float Zone Process, GaAs from Bridgman techniques. Wafer preparation.
Epitaxy Deposition: Epitaxial growth by vapor phase epitaxy (VPE) and molecular beam epitaxy (MBE).
Characterization; Various characterization methods for structural, electrical and optical properties. Basic idea of X-ray diffractometer, Scanning electron microscope, Transmission electron microscope and UV-VIS-NIR spectrophotometer.

Unit-2 (P-12)
Oxidation: Thermal Oxidation Process: Kinetics of Growth for thick and thin Oxide, Dry and Wet oxidation. Effects of high pressure and impurities, Impurity Redistribution during Oxidation, Masking property of Silicon Oxide, Oxide Quality. Chemical vapour deposition of silicon oxide, properties of silicon oxide, step coverage, P-glass flow.

Diffusion: Basic Diffusion Process: Diffusion Equation, Diffusion Profiles. Extrinsic Diffusion: Concentration Dependent Diffusivity. Lateral Diffusion.; Doping through Ion Implantation and its comparison with diffusion.

Unit-3 (P-12)
Lithographic Processes: Clean room, Optical lithography, exposure tools, masks, Photoresist, Pattern Transfer, Resolution Enhancement Technique. Electron Beam Lithography, X-ray Lithography and Ion Beam Lithography. Comparison between various lithographic techniques.
Etching: Wet Chemical Etching-basic process and few examples of etchants for semiconductors, insulators and conductors; Dry etching using plasma etching technique.;
Metallization: Uses of Physical Vapor Deposition and Chemical Vapor Deposition technique for Aluminum and Copper Metallization.

Unit-4 (P-09)
Process Integration: Passive components- Integrated Circuit Resistor, Integrated Circuit Inductor, Integrated Circuit Capacitor. Bipolar Technology: Basic fabrication process, Isolation techniques. MOSFET Technology: Basic fabrication process of NMOS, PMOS and CMOS technology.

Essential Text:

- Unit-1: Chapter-1&2, Gary S.May and S.M.Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons(2004); Chapter-5, Ludmila Eckertova, Physics of Thin films, 2nd Edition, Plenum Press(1986).
Unit-2: Chapter-3&6, Gary S.May and S.M.Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons(2004)
Unit-3: Chapter-4,5,8, Gary S.May and S.M.Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons(2004)
Unit-4: Chapter-9, Gary S.May and S.M.Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons(2004)

Suggested Books:

1. S. M. Sze, Semiconductor Devices: Physics and Technology, John Wiley & Sons(2002)
2. S. K. Gandhi, VLSI Fabrication Principles, 2nd edition, John Wiley & Sons(2010)
3. S. M. Sze, VLSI Technology, 2nd edition, Tata McGraw-Hill(2004)

Practical based on Semiconductor fabrication and Characterisation

1. To measure the resistivity of semiconductor crystal with temperature by four –probe method.
2. To determine the type (n or p) and mobility of semiconductor material using Hall-effect.
3. Oxidation process Simulation
4. Diffusion Process Simulation
5. To design a pattern using photolithographic process and its simulation
6. Process integration simulation