Micro and Nano Fabrication Methodologies

L(2):T(1):P(1) = 4 credits

Syllabus

1. **Clean Room Practices** 2 hours
   Cleanroom definition & classification (Class 1000, 100, 10); Airflow and HEPA filtration principles; Gowning procedure; Safety protocols and solvents handling; Chemical waste disposal

2. **Lithography Types** 4 hours
   Microprinting techniques; Optical lithography (contact, proximity, projection methods, resolution limits); Electron-beam lithography (EBL); Laser and X-ray lithography; Micro and Nanomolding techniques; Nanoimprint lithography (NIL); Extreme Ultraviolet Lithography (EUV), other emerging lithography methods

3. **UV Photolithography** 3 hours
   Principle; Positive and negative resists; Types of substrates; Process charts (substrate cleaning, photoresist spin coating, baking, UV exposure, Development etc.); Maskless lithography; Projection lithography

4. **Deposition Techniques** 4 hours
   Physical vapor deposition (Thermal evaporation, E-beam evaporation, Sputtering); Chemical vapor deposition (CVD); Film Characterization (Thickness, roughness and adhesion measurements); Doping and Diffusion

5. **Direct write lithography** 2 hours
   Functional printing and molding techniques; modified EBL and other techniques

6. **Self-assembly and self-forming methods** 2 hours
   SAM and desiccated crack patterning; Templates for large area patterning

7. **Device Integration** 2 hours
   Pattern transfer methods (Wet and dry etching, Lift-off); Interconnects; Bonding (wire Bonding, nano soldering); Packaging; electronic instrumentation; Probe station, Testing and characterization; Advanced techniques

8. **Applications** 4 hours
   Two- and three terminal device fabrication; In-plane and cross-bar geometries; Top and bottom gated FETs; MOS based devices; Integrated Circuits (ICs); Antennas & Micro-Electro-Mechanical Systems (MEMS); Sensors; Memory devices; Flexible devices

+ Assignments, Mini-seminars & Tests

Practical sessions 15 × 3 hours

1. Cleanroom entry
2. Optolithography (patterning the resist)
3. Metal deposition, Lift-off and Characterizing the electrodes
4. Shadow masking technique
5. Screen printing-based fabrication
6. Self-forming templated patterning
7. Micro-molding using PDMS

+ Report writing & Tests

Suggested Reading

1. Fundamental Principles of Optical Lithography: The Science of Microfabrication, Au: Chris Mack, 2007
2. Xia, Y. and Whitesides, G.M. (1998), Soft Lithography. Angewandte Chemie International Edition, 37, 550-575.
3. Chaudhari, M., Rajendrakumar B. A., Sanabhau D. B., Thin film Deposition Methods: A Critical Review, Intl. J. for Res. Appl. Sci. Engn. Tech. (2021), 9, 5215-5232.
4. Yifang Chen, Nanofabrication by electron beam lithography and its applications: A review, Microelectronic Engineering, 2015, 135, 57-72.
5. Fischer, A., Forsberg, F., Lapisa, M. et al. Integrating MEMS and ICs. Microsyst Nanoeng 1, 15005 (2015).