**COURSE SYLLABUS**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Title**：Nanomaterial Process | | | | |
| **Credits/Hours** | 3 /3 | **Course Number** | 158042 | **□Required ■Elective** |
| **Course Description**  This course covers a variaty of fabrication methods for fabricating nanomaterials. The methods include top-down fabrication (e.g., lithography, ball milling, machining, sputtering, etc.) and bottom-up fabrication (e.g., CVD, hydrothermal method, co-precipitation method, sol-gel method, self-assembly on noble metal). Each fabrication method is presented with principle, its’ advantages/disadvantages, example nanomaterials, and demonstrated applications. Finally, this course also includes the fundamental physics to understand the exotic electronic and optical properties of nanostructured materials, and single electron tunneling in single electron transitor and quantum dots, and TiO2-based photocatalysts and applications. | | | | |
| **Topics** | | | | |
| **Topic** | | **Content** | | |
| Introduction | | - Introduction to nanomaterials, synthesis methods, and applications.  - Introduction to nanostructured materials mainly from the perspective of nanoelectronics; brief history of the microelectronics industry; specifications and fabrication of wafers (mainly Si), clean rooms. | | |
| Top-down fabrication | | optical lithography, photomasks, diffraction limited resolution, resolution enhancement tools, lithography types (contact, proximity, projection), optical systems and light sources, mask aligners and steppers. | | |
| Top-down fabrication | | Introduction, Ball milling, Machining (focused ion beams, LASER ablation synthesis), Sputtering, Thermal evaporation, Plasma-assisted exfoliation, Arc discharge method, Electro-spinning | | |
| Bottom-up fabrication | | CVD, Hydrothermal method, Co-precipitation method, Sol-gel method, Template-based synthesis | | |
| Bottom-up fabrication | | - Surface functionalization, various form of assembly, self-assembled monolayers (SAMs) on noble metals (Au) , synthesis of Au nanoparticles (NPs), CdSe NPs, semiconductor nanowires.  - Carbon based nanomaterials (graphene, carbon nanotubes, fullerenes), metal chalcogenite and BN 2D materials and nanotubes. | | |
| Properties and Applications | | - Electronic (band) structure of materials (brief reminder), quantum confinement (using a simple particle-in-a-box model), implications for electronic and optical properties of e.g. quantum wells and quantum dots.  - Single electron tunneling in single electron transistors and quantum dots.  - TiO2-based nanomaterials for photocatalytic degradation of pollutants/contaminants. | | |