NMT-Nanonmanufacturing

NMT311 - Materials, Safety and Equipment Overview for Nanofabrication

This course provides an overview of basic nano-fabrication processing equipment and material chemistry and handling procedures. The focus is on clean room protocol, safety, environmental and health issues in equipment operation and materials handling. Topics to be covered will include clean room operation, safety and health issues; vacuum pump systems operation, turbo-molecular, cryo, diffusion, and dry mechanical pump systems; furnace operation, safety, environmental and health issues (covering horizontal and vertical tube furnaces, and rapid thermal annealing tools); chemical vapor deposition system operation, safety, environmental and health issues (covering gas delivery, corrosive and flammable gas storage, plumbing, regulators, and mass flow controllers); and vacuum deposition/etching system operation, safety, environmental and health issues (covering microwave and EF power supplies, tuners, heating and cooling units, vacuum gauges, valves, and process controllers). Specific materials handling issues will include DI water, solvents, cleaners, ion implantation sources, diffusion sources, photoresists, developers, metals, dielectrics, and toxic, flammable, corrosive and high purity gases as well as packaging materials.

NMT312 - Basic Nanofabrication Process

This course provides an overview of basic processing steps in nanofabrication (contact lithography, basic etching and deposition techniques). The majority of the course details a step-by-step description of the equipment and processes needed to fabricate devices and structures. Processing flow will be examined for structures such as microelectronic devices, including diode and the MOS capacitor. Students receive an in-depth introduction to basic lithography from wafer preparation to final inspection. Contamination issues in nanofabrication are discussed in detail. Students will learn the similarities and differences in both equipment and process flows for each configuration by undertaking hands-on processing.

NMT313 - Thin Films in Nanofabrication

This course covers advanced thin-film deposition and etching practices in nanofabrication. Advanced deposition techniques covered in the first part of the course include atmosphere, low-pressure and plasma-enhanced chemical vapor deposition, sputtering, thermal and electron beam evaporation. Materials studied include dielectrics (nitride, oxide), polysilicon (doped and undoped), and metals. The second part of the course focuses on advanced etching processes and techniques emphasizing reactive ion etching (single wafer, batch), high-density plasma systems (ECR, MERIE, ICP), ion beam etching, and wet chemical etching. Students will receive hands-on experience in depositing and etching dielectric, semiconductor and metallic materials using state-of-the-art tools and practicing many of the steps critical to nanofabrication of semiconductor devices, including microelectronics, MEMs devices, display structures and structures used in the biotechnology fields.

NMT314 - Advanced Lithography and Dielectrics for Nanofabrication

This course covers all aspects of advanced lithography from design and mask fabrication to pattern transfer and inspection. The course is divided into three major sections. The first section describes the advanced lithographic process from substrate preparation to exposure. Most of the emphasis is on understanding the nature and behavior of photoresist materials. The second section examines systems and techniques that define patterns. This section will introduce specialized optical masks and reticles, aligners, steppers and scanners. In addition, critical dimension (CD) control and profile control of photoresists will be investigated. The last section will discuss advanced optical lithographic techniques, such as phase shifting masks and illumination schemes as well as e-beam, e-ray, EUV and ion beam lithography. A section about engineering dielectrics is also discussed.

NMT315 - Materials Modification in Nanofabrication

This course will cover in detail the processing steps used in modifying material properties in nanofabrication. Evaluate thermal budget requirements using state-of-the-art tools. An intensive study of metals used in

nanotechnology aids the student in understanding the various methods of metalization, such as CVD, evaporation and sputtering. Metal applications for interconnect technologies will be examined. Aluminum, refractory metals and cooper deposition techniques and characterization will be discussed in detail along with topics such as diffusion barriers, contact resistance, electromigration, corrosion, stress effects and adhesion. Other modification technologies such as ion implantation, diffusion, and surface preparation and treatment are integrated as well. An intensive study of dielectric properties and materials, including dielectric constant engineering, mechanical, optical and electrical characteristics, poly, BSG, PSG, SOG and BPSG, gives the student further insight into advanced device fabrication. Material properties and basic device structures will be discussed for the optoelectronic market.

NMT316 - Characterization, Packaging, and Testing of Nanofabricated Structures

This course examines a variety of techniques and measurements essential for controlling device fabrication and final packaging. We will revisit concepts such as residual gas analysis introduced in NMT 211; optical emission spectroscopy (OES) and end point detection will be discussed as introduced in NMT 213. Characterization techniques, such as surface profilometry, advanced optical microscopy, optical thin film measurements, ellipsometry and resistivity/conductivity measurements, will be implemented on nanofabricated samples. Basic electrical measurements on device structures for yield analysis and process control will also be stressed. These will include breakdown measurements, junction testing, C-V and I-V tests, and simple transistor characterization. In addition, we will examine mechanical as well as electrical characteristics of nanostructures for biological/biomedical applications. The students will perform DNA analysis by learning and performing the polymerase chain reaction for DNA replication. They will also study and manufacture microfluidic channels for biological analysis. An extensive overview of biology will be given with emphasis on biocompatible materials. The student will also learn about the manufacturing issues involved in subjects such as interconnects, isolation and final device assembly. The importance of planarization techniques, such as deposition/etchback and chemical/mechanical polishing, will be emphasized. Lastly, packaging procedures, such as die separation, inspection bonding, sealing and final test for both conventional IC's and novel MEM and biomedical devices, will be examined.