State-of-the-art Nanofabrication
Fundamentals and Advanced Applications

Disney Coronado Springs Resort
Tuesday, May 30, 2017
8:30 am-3:30 pm

Program

8:30 - 8:45 am	**Registration**
8:45 - 9:00 am	**Welcome**
9:00 - 10:00 am	**Focused Electron and Ion Beam Induced Synthesis** Philip D. Rack, Ph.D. University of Tennessee, Knoxville
10:00 - 11:00 am	**Atomic Layer Processes** Adam Schwartzberg, Ph.D. The Molecular Foundry Lawrence Berkeley National Laboratory
11:00 - 11:15 am	**Break**
11:15 am - 12:15 pm	**Nanobiology: Challenges and Opportunities for Nanoengineers** Shalom J. Wind, Ph.D. Columbia University
12:15 - 1:30 pm	**LUNCH (on your own)**
1:30 - 2:30 pm	**Block Copolymer Directed Self-Assembly to Enhance Nanofabrication** Gregory Doerk, Ph.D. Center for Functional Nanomaterials Brookhaven National Laboratory
2:30 - 3:30 pm	**Nanoimprint Lithography** Wei Wu, Ph.D. University of Southern California
3:30 pm	**EIPBN COMMERCIAL SESSION**

Focused Electron and Ion Beam Induced Synthesis

Electron and ion beam induced synthesis are direct-write nanoscale synthesis approaches in which the focused charged particle beam induces a scission event of a precursor molecule adsorbed on a substrate surface which either condenses (deposition) or reacts to form a volatile species with the substrate (etching). For ion beams, nuclear-nuclear energy loss mechanisms also contributes which can lead to near surface atom sputtering. Strategic scanning of the focused beam can thus conveniently deposit nanoscale 2D and 3D objects. The main limitation is the fact that most of the synthesis is performed at room temperature and thus residual precursor ligands are incorporated into the deposits. To this end, there has been a recent international effort to explore *in situ* and *ex situ* purification techniques. In this presentation we will briefly overview relevant electron(ion)-precursor-solid interactions relevant to focused beam induced processing. To facilitate this discussion we will highlight some of our recent Monte Carlo simulations which illustrate some of the relevant mechanisms that are operative during the nanoscale synthesis. Subsequently we will overview various purification strategies and in particular demonstrate some of our recent work exploring laser assisted focused beam induced synthesis.

Atomic layer deposition and etching

The addition or removal of single atomic layers with atomically selective precision at the wafer scale is critical to revolutionizing nanofabrication for basic research and industrial application alike. Atomic layer deposition (ALD) and atomic layer etching (ALE) are the two sides of this coin. In this short course I will introduce the chemical and physical principles of ALD and ALE and present several recent advances that demonstrate the potential of these techniques.

Nanobiology: Challenges and Opportunities for Nanoengineers

The overall purpose of this lecture is to provide scientists and engineers with backgrounds and training in the Physical Sciences and Engineering a perspective on how they can adapt their skills to the Life Sciences. The lecture will begin with a brief survey of basic concepts in biology, with a focus on key properties of biomolecules and cells. It will then address how tools and processes developed and used to fabricate semiconductor devices can be applied and adapted to solve important questions in biology and biomedicine, and conversely, how biological concepts and biomaterials can be used in non-biological, technological applications. Specific examples ranging from single-molecule sensors to stem cell differentiation will be discussed. Time will also be devoted to some of the unique challenges encountered by physical scientists and engineers when learning to interact with members of the biomedical community.

Block Copolymer Directed Self-Assembly to Enhance Nanofabrication

Block copolymers, comprising two or more chemically distinct polymer chains joined by covalent bonds, can form well-ordered periodic patterns through microphase separation, with features ranging from ~5-200 nm. In nanofabrication, the directed self-assembly (DSA) of block copolymers offers an enticing way to enhance and extend current or emerging lithographic technologies for both the lab and fab. Here I will

provide a survey of lithographic-based DSA, highlighting its progress, challenges and opportunities. This talk will touch on the intricacies of the field including directing strategies (e.g. chemoepitaxy and graphoepitaxy), materials, processing, applications, integration strategies, scaling, defectivity, characterization, and pattern transfer. Recent developments as well as practical guidelines will be featured.

Nanoimprint Lithography

Nanoimprint lithography is a high resolution, high throughput and cost effective lithography technology. After 22 years of fast growth, great progress has been made. Nanoimprint lithography has grown from a “smart invention” to a technology on the ITRS roadmap and with applications much beyond semiconductors. In this short course, we will cover both the basics and the sciences behind nanoimprint lithography. Applications and industrial perspectives will be presented too.