

## **Fabrication and Characterization of Nanostructures**

Classroom: A parallel flow of top-down and bottom-up nanofabrication is followed to allow fast and simultaneous acquisition of knowledge in both routes from participating students.

- *For the top down nanofabrication* emphasis is given on the pattern transfer step using plasma etching following the creation of a template. The plasma etching environment is studied namely the basic plasma physics and chemistry: basic plasma quantities, electron impact processes, gas phase chemistry, continuity equations for charged and neutral species. Plasma diagnostics. Surface chemistry during etching or deposition, micro and nanoscale topography evolution and nanotexture formation, as well as elements of plasma processing issues and plasma nanoscience. Characterization of surfaces and surface metrics for ordered, quasi-ordered, and fractal surfaces are studied. Surface measurement methods are presented using AFM, SEM and profilometry, and ellipsometry for plasma etched or plasma deposited films.
- *For the bottom-up synthesis* emphasis is given on nanoparticle synthesis by various methods emphasizing the sol-gel method, as well as nanofiber, nanotube, and nanosheet formation. The nanomechanical properties are stressed; hardness, modulus, stiffness, coefficient of friction, onset of plasticity, creep and many more local properties are analyzed and discussed. Plasticity and local deformation mechanisms are studied. The toxicity issues of nanoparticles are also addressed. Bridging of nanomechanical to micro/meso mechanical properties is discussed.

### Laboratory:

#### *Top-down approach*

- Plasma reactor operation, and vacuum techniques
- Plasma diagnostics, thickness measurement using spectroscopic ellipsometry
- Plasma nanotexturing, Plasma surface modification and wetting control.
- Microstructure fabrication for MEMS, and nanowire fabrication for photovoltaics.

#### *Bottom-Up approach*

- Sol-gel synthesis of TiO<sub>2</sub> nanoparticles
- Nanomechanical properties of thin films
- Nanomechanical properties of nanofibers / nanorods

Nanotribological properties of nanostructures