Fall 2008: MAT 265 Nanophase and Nanoparticulate Materials

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Catalog Description:

The course will introduce graduate students to nanophase and nanoparticulate inorganic materials and their applications. The emphasis will be on how the properties of materials change when their size is diminished. The manner in which nanomaterials (particularly nanoparticulate materials) bridge the world of molecules with the world of solids will be pointed out. Preparation, characterization, and applications of nanomaterials will be discussed at length. Function, and applications will be emphasized when possible.

Prerequisites:

Graduate students; Materials 218, Chemistry 173 B, or equivalent.
Undergraduates with prior permission.

References:

Current literature

Topics covered, by phenomena:

Colloidal physical chemistry; size effects on crystal structure, electronic, optical, and magnetic properties; strengths of nanophase materials; nanophase self-assembly.

Topics covered, by material:

Nanophase ceramic materials; Nanoparticles of metals, semiconductors (quantum dots including porous silicon) and oxides (including magnetic oxides); Carbon nanotubes and carbon onions; Inorganic nanowires and nanotubes, Ultrathin organic films: SAMs, Langmuir & Langmuir-Blodgett; Natural quantum wells in layered semiconductors.

Detailed Outline:

1. Structures in colloidal physical chemistry
2. Ultrathin organic films – SAMs, Langmuir, & Langmuir-Blodgett
3. Nanophase ceramic materials
4. Nanoparticles of metals, semiconductors (quantum dots including porous silicon) and oxides (including magnetic oxides)
    (a) Size and metal-insulator transitions

   (b) Quantum confinement in semiconductors
   (c) Nanomagnetism
5. Carbon nanotubes and onions
6. Natural quantum wells in layered semiconductors, and molecular systems
7. The biology/nanomaterials interface
8. Proximal probe techniques (STM and AFM) and their uses in nanopatterning

Grading

Based on assignments, whiteboard presentations on specific papers, and on a final presentation.