SYLLABUS

Concepts in Nanoscale Materials: Interdisciplinary Science

Physics 8410

Spring 2013: January 22 through May 9

Time: 1:00 pm -2:15 pm CST, Tuesdays and Thursdays

Location: Life Science Center, room 001, MU campus

Instructor Name: Paul Miceli

Prerequisite: Introduction to Modern Physics (Phys 3150), or equivalent; or instructor consent.

COURSE DESCRIPTION

This 3 credit-hour graduate-level course will explore the fundamental physical behavior and the characterization of nano-scale materials through lectures and writing assignments. Unique perspectives and insights into nano-scale materials will be offered by a team of lecturers from MU and Indiana University via video link.

As an interdisciplinary subject, the course will draw upon physics, chemistry, materials science and engineering to understand the underlying mechanisms that operate in the growth and behavior of nano-scale materials. Students will also learn about the characterization of nano-scale materials with neutron scattering techniques, which uniquely cover a broad range of length and time scales that are essential for understanding nano-scale science.

Major topics that will be covered in the course include: (i) an introduction to elementary solid state physics, (ii) physical mechanisms and interactions at the surfaces and interfaces of materials, (iii) an introduction to lithography, (iv) soft-matter at the nano-scale, and (v) nano-porous materials.

INSTRUCTOR INFORMATION

Instructor and Coordinator: Paul Miceli
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Instructor and Coordinator at IU: David Baxter
E-mail: baxterd@indiana.edu)

Instructors:
Gary Baker (Chemistry, MU, Bakergar@missouri.edu)
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Paul Sokol (Physics, IU, pesokol@indiana.edu)
Haskell Taub (Physics, MU, TaubH@missouri.edu)
Carlos Wexler (Physics, MU, wexlerc@missouri.edu)

TEXTBOOKS AND MATERIALS: No required textbooks. Lecture notes and references therein. Power-point slides will be provided through "Dropbox".

COURSE POLICIES (attendance, absences, submitting late work):
Students are expected to attend all lectures and in-class discussions. Writing assignments should be submitted by their due dates. After that, **no late assignments will be accepted**.

To encourage interdisciplinary and diversified discussions, the students will be divided into groups of 3-4 members according to their background and locations. After the end of each 50-minute lecture, the students are required to participate actively in the 20-minute, in-class group discussions about the pre-assigned questions. The students of each group are also expected to discuss and share information on the assigned projects for the term reports and the final paper; however, **students should submit their own writing assignments independently**.

ASSIGNMENTS

- There will be a 20-minute **in-class group discussion** after each 50-minute lecture. Questions for discussion will be provided before each lecture by the instructor. Participation in the group discussions will contribute 5% toward the total course grade.

- There will be **3 term reports**. Each group will search the literature and analyze the data cooperatively. Then **every student will write his/her own term report** based on the group discussions. Each term report will account for 20% of the total grade.

  Term Report Format: (1) Times New Roman 12-point font size; a font size of 10 points may be used for mathematical formulas or equations; (2) the margins must be one inch on all sides; (3) a standard, single-column, double-space format should be used; (4) tables, figures and captions should be placed after the bibliography; (5) the length requirement of the term report is 4 pages, excluding bibliography, tables, figures, and captions.

- There will be a **final paper**. In last four weeks of course, students are required to write an article following the format of a peer-reviewed journal article. The format requirement of the final paper is the same as that of the term report, except that the length requirement is 6 pages. Students will select a topic (with instructor approval), which examines an issue in greater depth. The article will be submitted and evaluated in two drafts. The second draft will serve as the final exam for the course. The final paper will contribute 35% toward the final grade.

- Additional notes about writing assignments:
  (1) Your writing should represent a critical evaluation of a topic rather than a review or summary of it. Good writing, clarity and accuracy are expected.
  (2) You may use data and figures that you find in literature as if they were your own research results. However, cite the relevant references in your text and figure captions when you use the results.
  (3) One may not copy sentences and paragraphs from literature. Copying of other people's sentences and paragraphs is considered to be "plagiarism" and will result in a failing grade on an assignment if found.
  (4) **GRADING SCALE** (include +/- grades)
  A: > 85% B: 70-85% C: 60-70% D: 40-60% F: < 40%

Course Schedule

Essential Concepts in Solid State Physics – Paul Miceli

1. *Solid State Crystalline Structures*	Jan. 22
2. *Diffraction from Crystals and the Reciprocal Lattice Vector*	Jan. 24
3. *Scattering from the Interfaces of Nanomaterials: Neutron and X-ray Characterization*	Jan. 29
4. *Atomic Vibrations and Normal Modes*	Jan. 31
5. *The Electrons: The Sommerfeld Model and Bands*	Feb. 5

Project 1: X-ray and Neutron Reflectivity Characterization of Nanoscale Interfaces Due Feb. 15

Growth at Surfaces

6. *Wetting and Adsorption: Theory*; Peter Pfeifer	Feb. 7
7. *Physisorption on Surfaces: Experiment & Neutron Scattering Studies*; Hak Taub	Feb. 12
8. *Epitaxial Crystal Growth: Non-Equilibrium Nanoscale Phenomena*; Miceli	Feb. 14
9. *Quantum Mechanics and Crystal Growth: Quantum Size Effects*; Miceli	Feb. 19
10. *The Building Blocks of Nano: A Wet Chemical Approach*; Gary Baker (MU Chemistry)	Feb. 21

IGERT students travel to ORNL-SNS Feb 24-Mar 2

(Time change TBA!: broadcast will be in the morning from ORNL)

11. *Introduction to Small Angle Neutron Scattering (SANS)*; Roger Pynn (IU)	(Tu)Feb. 26
12. *Multilayers: A Prototypical Class of Nanostructured Materials*; David Baxter (IU)	(Th)Feb. 28

Materials Modification

13. *Lithography-1*; Gavin King	Mar. 5
14. *Lithography-2*; Gavin King	Mar. 7

Project 2: Interface Studies of Nanoscale Materials Due Mar. 15

Soft Matter Nano-Structures

15. *Simulations of Alkanes at Surfaces*; Carlos Wexler	Mar. 12
16. *Neutron Scattering Studies of Alkane Nanostructures on Si*; Haskell Taub	Mar. 14

No Class: March Meeting of the American Physical Society, Mar. 18-22.

No Class: Spring Break at MU, Mar. 23-31

17. *Organic Molecules: Nanoscale Growth and Structure*; Suchi Guha;	Apr. 2
18. *Nanoscale Structure of Conjugated Polymers*; Suchi Guha;	Apr. 4
19. *SANS Studies of Polymers, Colloids and Emulsions;* Roger Pynn	Apr. 9
20. *Neutron Reflectivity from Polymer and Magnetic Films*; Helmut Kaiser	Apr. 11

Project 3: Nanoscale Phenomena in Liquid Crystals Due Apr. 18

Porous NanoMaterials

21. *Fluids in Nanoporous Confined Geometries: Neutron Scattering*; Paul Sokol (IU)	Apr. 16
22. *Inelastic Neutron Scattering from Hydrogen in Porous Carbons*; Carlos Wexler	Apr. 18
23. *Fluids in Nanoporous Confined Geometries: Neutron Scattering*; Paul Sokol (IU)	Apr. 23

Apr. 25 - May 9 students work on final paper: 1st draft due May 7; final version due May 14.