MSE 110: Structures and Properties of Materials

Spring 2018

Lecture: MW 12-1:15 pm, COB 264

Lab: M 4:30-6:20 pm, COB 262
W 4:30-6:20 pm, SE2 160

Final: May 11 (Friday), 8-11 am, COB 264

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Office Hours: MW 2-3 pm in SE2, 283

1. COURSE DESCRIPTION

This course will cover the following topics for inorganic and organic solids. Synthetic methods. Crystal growth. Structure and bonding of materials and their relationship to the mechanical, thermal, electrical, optical, and magnetic properties of materials, within the context of structure-properties-processing-performance relationships. The role of defects. Anisotropy in materials. Special topics include dielectrics, superconductors, layered compounds. Characterization methods and device applications will also be discussed.

Pre-requisite: ENGR 45, CHEM 2, PHYS 8.

CatCourses will be used for course announcements, and for the distribution of class materials.

2. LEARNING OUTCOMES

After successful completion of this course, you will be able to:

- Describe general approaches for the synthesis and growth of inorganic and organic crystals;
- Have a good understanding of crystal structures and its relationship to the electrical, thermal, magnetic, optical, and mechanical properties of solid-state materails;
- Understand the similarities and differences between inorganic and organic solids (small molecule vs. polymer) in terms of structure-property-processing relationships;
- Identify suitable characterization methods for analyzing the electrical, thermal, magnetic, optical, and mechanical properties for inorganic and organic solids.

You will practice the related skills in homework and discussion exercises. You will demonstrate your proficiency formally in the midterm and final examinations.

Relationship to MSE program learning outcomes (PLOs):

PLO-1: Possess a broad foundation in the fundamentals and current topics in either materials or biomaterials science and engineering, as well as in-depth understanding of their chosen research topic area;

PLO 2: Exhibit the quantitative experimental and analytical skills necessary to conduct and lead independent research and contribute to knowledge in their chosen area.

3. TEXT

There are no required textbooks for this class. Your class notes and assigned readings from current research and professional literature will be your primary source of reference material. As a result, your attendence in class is expected and will be crucial to your mastery of course materials. The following textbooks are recommended as additional resources.

- **Basic Solid State Chemistry**, 2nd Ed., Anthony R. West
- **The Solid State**, 3rd Ed., Harold M. Rosenberg
- **Introduction to Polymers**, 3rd Ed., Robert J. Young, Peter A. Lovell

4. HOMEWORK

Homework will be *due 1 week after the assigned date*. **Late homework will not be accepted.** To account for illness and other emergencies, the lowest homework score will be dropped.

You are encouraged to work with your peers when doing homework. However, each student must turn in his/her own homework assignment and it must reflect his/her own work. You must explicitly identify all peers with whom you worked.

5. EXAMS

There will be two in-class midterm exams as indicated on the accompanying schedule. There will also be a comprehensive final exam. There will be no make-up exams. If you are sick during a regularly scheduled exam, please bring a note from a doctor verifying your illness. Your course grade will then be determined by the rest of your work.

6. GRADE DETERMINATION

Your final grade will be based on the following components:

- homework (10%)
- presentation (10%)
- first midterm (20%)
- second midterm (20%)
- final exam (40%)

7. DROPPING CLASS

Please see the UC Merced General Catalog and the Registrar's / Student First website for details.

8. SPECIAL ACCOMMODATIONS

The University of California Merced is committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. If you qualify for accommodations because of a disability, please submit a letter from the Disability Services Center to me in a timely manner (during the first three weeks of the semester, except for unusual circumstances) so that your needs may be addressed. Student Affairs determines accommodations based on documented disabilities.

9. ACADEMIC HONESTY AND CONDUCT

Students are expected to complete their own work and to abide by the UC Merced academic honesty policy, which can be found on the Student Life website http://studentlife.ucmerced.edu/ under the "Student Judicial Affairs" link. Any work submitted by a student in this course for academic credit will be the student's own work.

Note that most of the handouts provided in this course are protected by copyright, and are flagged accordingly on CatCourses. They are for your *personal* use only. Re-posting the files or their contents on sites such as (for example) "Course Hero" is an explicit violation of this copyright.

Students and instructors are expected to honor UC Merced's Founding Principles of Community: http://www.ucmerced.edu/about_ucmerced/values.asp.

10. WEEKLY SCHEDULE

Week	Lecture Topics
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1	Synthetic methods for growing inorgnaic crystals, including single crystal ingots, nanocrystals, and crystals on surfaces, alloys.
2	Crystal structures; defects.
3	Crystal structures & defects (continued); crystallographic characterization methods, including x-ray, electron, synchrotron, and neutron scattering.
4	Thermal conductivity and characterization methods. Electrical properties.
5	Electrical properties (continued); semiconductors, including band gaps, doping; p-n junctions; characterization methods.
6	Midterm 1. Magnetic properties, including paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism.
7	Mechanical properties, including plastic and elastic deformation under tension, compression, torsion; hardness; toughness; characterization methods.
8	Dielectrics; superconductors; amorphous materials; layered compounds.
9	Introduction to organic solids, including small molecules and polymers. Organic crystal growth: solution- and vapor-based routes.
10	Midterm 2. Structure-property relationships for organic solids: crystals structures, anisotropy; relationships between chemical structue and crystollographic packing.
11	Structure-property relationships for organic solids: molecular engineering, conformation, phase separation; mechanical properties. Characterization methods.
12	Organic semiconductors and metals: discovery, band structures, doping.
13	Electrical, optical, and mechanical properties of organic semiconductors and metals.
14	Composite materials: structure-property relationships.
15	Catch up & review.