Structure-Property Relations in Materials

ME/MATS 570, Fall 2014 Class: Graf 307, Wd,Fri 8:00–09:50
Instructor: **Alex Greaney** Office hours: Dearborn 304, Wd 17:00 & Fr 10:00

Prerequisites, Co-requisites and Enforced Prerequisites: None

Course Credits: This course combines approximately 120 hours of instruction and assignments for 4 credits.

Course Content: Fundamentals of the interactions between the structure and properties of materials. Atomic bonding and atom interactions. Geometric and algebraic representations of symmetry. Introduction to phase equilibria. Phenomenological background of elasticity and plasticity in materials. Anisotropic materials and tensor representations. Influence of structure on thermal, electrical, and optical properties of materials.

Topics covered: Planned sequence of topics covered (this list could change).

- Electronic structure and bonding
  - Electrons, wave functions, and all that Handout
  - Electronic structure of atoms Tilley: 1.–1.2
  - Bonding Tilley: 2, & 3.1
  - Band structure Tilley: 2.3.3–2.3.5
- Atomic structure and crystallography
  - Crystals
    - Lattices, and translational symmetry Tilley: 5.1.1–5.1.2, + handout
    - Rotational symmetry, stereographic projections, and space groups Tilley: 5.1.3 + handout
    - Crystal planes, reciprocal lattices and Miller indices Tilley: 5.14–3.5
    - Diffraction Tilley: 5.2
    - Tensor properties Handout
    - Crystal structures Tilley: 5.3
    - Crystal defects Tilley: 3.4–3.5
  - Quasicrystals, amorphous materials and glasses Tilley: 3.2.3–3.2.6, & 6.3
  - Polymers and molecular solids Tilley: 6.4
- Microstructure and phase equilibria
  - Solid solutions Tilley: 3.4.1
  - Phase diagrams Tilley: 4
  - Solidification/Nucleation and growth Tilley: 3.3
- Structure-Property Relationships
  - Mechanical Properties Tilley: 10.1–10.4
  - Electrical Properties Tilley: 13.1–13.2, & 11–11.3.4
  - Thermal Properties Tilley: 15–15.4
  - Optical Properties Tilley: 14.3, & 14.9

Measurable Student Learning Outcomes:

1. Predict basic physical properties of materials based on knowledge of their structure, atomic composition and chemical bonding.
2. Readily describe the structure of crystalline materials using the nomenclature of Bravais lattices and Miller Indices.
3. Describe the symmetry elements for crystalline materials.
4. Use a binary phase diagram to quantitatively describe the compositions, phases and microstructures developed in binary solid systems.
5. Describe the mechanical properties of materials in terms of elastic and plastic behavior

Evaluation of Student Performance: midterm 1: 30%, midterm 2: 30%, final (comprehensive): 40%. Homework is assigned weekly but will not be collected or graded. Homework and reading asignments are an import excersize that helps you understand and apply the concepts covvered in class.

Learning Resources: The required text for this class is:
R. Tilley, *Understanding Solids: The Science of Materials*, Wiley 2^{nd} Ed. (2013) (required)

Suggested textbooks are:

- Barrett, Nix and Tetelman, *The Principles of Engineering Materials*, Prentice Hall (1973)
- Anderson, LEaver, Rawlings and Alexander, *Materials Science*, Chapman & Hall (1990)
- A. Kelly, G. W. Groves, and P. Kidd, *Crystallography and Crystal Defects*, Wiley (2000)
- S. Elliott, *The Physics and Chemistry of Solids*, Wiley (1998)
- W.D. Callister, *Materials Science and Engineering: An Introduction, 8th Ed.*, Wiley (2009)
- J. F. Nye, *Physical Properties of Crystals—Their Representation by Tensors and Matrices*, Oxford (1985)
- Gersten and Smith, *The Physics and Chemistry of Materials*, Wiley (2001)

Office Hours: Office hours will be held in 304 Dearborn Hall on Wednesday from 5–6pm and Fridays after class from 10–11am, or by appointment if you can not make these times.

Academic Dishonesty: Oregon State University provides clear definition and sanctions for academic dishonesty. As a result, academic dishonesty of any kind is not tolerated. For suspected academic dishonesty, a meeting with the student will take place and a formal report to the Chair of the Department, to the student's dean, and to the Student Conduct Office may follow. Students caught cheating, plagiarizing, or participating in any form of academic dishonesty may receive an F or other penalty on the assignment or test and possibly in the course. If you have any questions about the definition of academic dishonesty or the extent of sanctions that may result from dishonest behavior, it is important to access information on the OSU Student Conduct Website at: `http://oregonstate.edu/admin/stucon/index.htm`

Statement Regarding Students with Disabilities: Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098.