ME/MSE 6796 Structure-Property Relationships
(3 credit hour, graduate course for ME/MSE)

Instructor: Dr. Hailong Chen (email: hailong.chen@me.gatech.edu)

Version 1.0 released Aug 12/2021

Special note: the syllabus is subject to changes due to the circumstance changes caused by the COVID-19 pandemic situation.

Grading: Exams- 40%, (two midterms, no final) homework-15%, final presentation 20%, final report 15%, and quizzes 10%.

Attendance: Attendance at all classes is expected. Periodic quizzes are given to encourage attendance and promote day-by-day learning. In case of campus close or the course turning into remote mode, quizzes will be given online.

Background: ME/MSE 6796 is graduate course serving as the introduction to general knowledge of structure of solid state (crystalline and glassy) materials and the relationship between their structure and properties of interest, and as an entrance to advanced, more specific structure-property relationships. The case studies will be focused on inorganic materials. Organic molecular compounds and polymer materials are not covered.

Course Purpose and Description:

Learning Objectives: Upon completion of this course, the students are expected to have the following knowledge.

1. Understand the structure of solid materials, e.g. the mathematical and physical descriptions of the structure, space groups, symmetry and symmetry operations.

2. Know how to characterize and detect the structure of materials. Understand the principles of most popular structural characterization techniques.

3. Understand the origin of the physical and chemical properties of interests of materials and the relationship between the properties and the structure.

4. Know the common principles of materials design. Understand how to control the synthesis to obtain desire structure of material, so as to achieve desire properties of the materials and performances of devices.

Course Syllabus:

Homework

Problem sets will be handed out and turned in at class. To receive credit, you must hand in solutions on the due date. Late submission will not be accepted unless there is a legitimate reason with proofs (e.g., hospitalization, emergency, etc.); Contact me as soon as possible to coordinate late submission.

Exams

Two midterm exams will be given during the semester. The location will be in the lecture meeting classroom. Time to be announced at class according to the progress of teaching.

Final report and presentation

The final project includes a written report and an oral presentation, which summarizes a small subfield, a specific study or a research project that demonstrated how certain properties of materials are determined/affected/tuned by their structure, including necessary synthesis/preparation, structure characterization and device testing.

Academic Honor Code:

I expect compliance with Georgia Tech's Academic Honor Code; Please read and understand this document (if you have not already done so). You are allowed to work in groups on all homework, but any work you turn in must be written by yourself and reflect your own understanding. If it is obvious that direct copying has occurred, we will disallow that homework.

Instructor Office hour

Time: Regular office hour to be announced after semester starts and all schedules are set. Special office hour can be arranged by email appointment.
Location: 3rd floor common area of Love building
TA (TBD) TA office hour (TBD)

Tentative Teaching Schedule (subject to change depending on the progress of class)

Week 1-5 Structure of materials
- Atom, bonding, crystal, lattice, symmetry and symmetry operations
- Structure of crystalline materials
- Structure of glassy materials
- Structure of composite and other materials

Week 5-8 Structure characterization methods
- Diffraction (X-ray, Neutron and electron)
- Other scattering methods (XAS, IR, Raman)
- Other spectroscopy (solid state NMR, Mossbauer, etc.)

Week 9-14 Properties and structure-property relationships
- Mechanical properties
- Electronic properties
- Ionic properties
- Optical properties and magnetic properties

Week 14-15 Material synthesis and structure controlling and tuning
- Materials synthesis methods
- Materials design, computational and empirical.
- In situ characterizations