MSE 6402 – Structure and Defects

School of Materials Science and Engineering
Georgia Institute of Technology

Spring Semester 2023

Course Objective
To provide students with a fundamental understanding of structural features of crystalline materials, including point and space groups, representative crystal structures, point and linear defects, and the effect of symmetry and defects on materials properties

Mode of Instruction
This course will be delivered in the residential mode. Most lectures may be recorded in case some students may be unable to make it to the class.

Lecture
3:30 - 4:45pm W F, Instruction Center 209

Instructors
Meilin Liu
Office Love 258
Phone 894-6114
E-mail meilin.liu@mse.gatech.edu

Office Hour
W F 5 - 6:30 pm or by appointment, also call or e-mail

Teaching Assistant
Weining Wang: office hour time/location/e-mail/phone
TBD

Homework
Problems will be assigned periodically and solutions will be posted later. Homework may be collected but will not be graded.

Exam/grading
3 Exams
Exam 1 – Structure & symmetry of materials
Exam 2 – Structure-property relationships
Exam 3 – Point and linear defects

Grading Basis
Scale
>90% A guaranteed
>80% B guaranteed
>70% C guaranteed
>60% D guaranteed
Learning Objectives:

Upon completion of this course, students will be able to:

1. Deduce point groups of simple crystal structures and geometric figures.
2. Understand space group notations and all symmetry elements associated with each space group.
3. Become familiar with structural features of crystalline materials.
4. Understand point defects and linear defects in crystalline solids.
5. Understand the inherent correlation between crystal structure, defects, and properties of materials.

Academic Integrity

Students are reminded of the obligations and expectations associated with the Georgia Tech Academic Honor Code and Student Code of Conduct, available online at www.honor.gatech.edu. Academic dishonesty will not be tolerated, including cheating, lying about course matters, plagiarism, or helping others commit a violation of the Honor Code.

Learning Accommodations:

For students with documented disabilities, we will make classroom accommodations in accordance with the ADAPTS office (http://www.adapts.gatech.edu). However, this must be arranged in advance.

Electronic Devices

Silence all electronic devices (cell phones, smart watches, etc.) during class. The only electronic device that you may have out and available for use during an exam is a commercially available calculator.

References

1. Lecture notes – to be posted on Canvas
   https://gatech-primo.hosted.exlibrisgroup.com/permalink/f/1vgrnp4/01GALI_GIT_ALMA51247241770002947
   https://gatech-primo.hosted.exlibrisgroup.com/permalink/f/1vgrnp4/01GALI_GIT_ALMA51158461550002
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<thead>
<tr>
<th># of Lectures</th>
<th>Date</th>
<th>Topics</th>
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<td></td>
<td><strong>Crystal Structure and Symmetry</strong></td>
<td>1,2,3,4</td>
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<td>Overview of the course; Geometric principles: Representative structures of important materials: metals, alloys, semiconductors, and ceramics (AX, AX₂, ABX₃, AB₂X₄ compounds: Fluorite, Perovskite, Spinel, Garnet, etc.); Pauling rules; Crystal Symmetry: Symmetry operations; Crystallographic point groups; Magnetic (color) point groups; Space groups</td>
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<td>Feb-15</td>
<td><strong>Exam 1: Crystal Structure and Symmetry (100 pts)</strong></td>
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<td><strong>Structure-property relationships</strong></td>
<td>1,2,5</td>
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<td>Mar 17</td>
<td>Non-crystallographic point groups: Curie (limiting) groups (symmetry of force fields and physical properties) Introduction to anisotropy and tensors Effect of crystal symmetry on properties of materials: Neumann’s principles; Formulation of physical interactions Number of independent components of tensor properties in different crystals; Ferro-electricity, Ferrimagnetism, and other physical interactions</td>
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<td><strong>Exam 2: Structure-property relationships (100 pts)</strong></td>
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<td><strong>Point and Linear Defects</strong></td>
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<td>Apr 21</td>
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<td><strong>Exam 3: Defects (100 pts); 2:40 – 4:30 PM</strong></td>
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<td>May 3</td>
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