MSE_1053: Structure of Crystals and Diffraction

Course Syllabus Fall 2021

Catalog Description

Basic crystallography of materials; symmetry; point groups and space groups; tensor properties of crystals; diffraction methods in materials science; atomic packing and structures; glassy state, polycrystalline aggregates; grain boundaries and interfaces in materials; textures; multiphase materials; quantitative stereology and microstructural characterization; thin films. (3 credits)

Schedule: Wednesdays, 8:15-11:00am

Lecture Room: Zone 3 – 103

Instructor: Charles Hua charleshua@scu.edu.cn, **17760422493 (WeChat and Mobile)**
Teaching Assistant: 罗伊雯，2018141522067@stu.scu.edu.cn；15826068515

When emailing the instructor, include "MSE1053" in the subject field of your message. Use your university email account (student_ID_number@stu.scu.edu.cn); mail from other accounts might be stopped by the SCU spam filter.

Textbook

1. M. De Graef and M.E. McHenry, "Structure of Materials", 2nd edition, Cambridge University Press, IBSN *978-1-107-00587-7 (2012).*

Reference books

1. *H. K. D. H. Bhadeshia, "Geometry of crystals, polycrystals, and phase transformations", IBSN13: 978-1-138-07078-3, John Wiley, Aug. 25, 2017.*
2. C. Hammond, The Basics of Crystallography and Diffraction, Oxford University Press, 2nd edition (2000) and reprinted 2003.
3. Kelly and G.W. Groves, Crystallography and Crystal Defects, Addison-Wesley (1970);
4. Kelly, G.W. Groves and P. Kidd, Crystallography and Crystal Defects, John Wiley & Sons (2000).
5. M.J. Buerger, Elementary Crystallography, Wiley (1963).
6. B.D. Cullity, Elements of X-Ray Diffraction, Addison-Wesley (1978).
7. B.D. Cullity and S.R. Stock, Elements of X-Ray Diffraction, 3rd Edition Prentice Hall (2001).
8. K.J. Kurdzydlowski and B. Ralph, The Quantitative Description of the Microstructure of Materials, CRC (1995).
9. D.M. Adams, Inorganic Solids, Wiley (1974).
10. V. Randle, Microstructure Determination and its Applications, Inst. Of Materials, London (1992).

11. V. Randle, The Role of Coincidence Site Lattice in Grain Boundary Engineering, Inst. Of Materials, London (1996).
12. C.S. Barrett and T.B. Massalski, Structure of Metals, McGraw-Hill, 3rd ed. (1966).
13. R. Tiley, Crystals and Crystal Structures, Wiley (2006).
14. S.M. Allen and E.L. Thomas, "Structure of Materials", Wiley, 1999.

- You *must* have taken:
  - Materials Structure and Properties (Or equivalent, or consent of instructor)

- You *should* have taken:
  - MSE 1052 – Manufacturing Processes and Analysis (But not strictly required)
- It is assumed that the student has a basic working knowledge of:
  - **Phase diagrams:** reading and understanding the diagrams, identifying phases and eutectics, solubility and relative composition of phases
  - **Basic kinetics:** equilibrium cooling (i.e. through a phase boundary) and time-temperature-transformation diagrams
  - **Microstructure:** Phases, eutectics, lamellae, connection to phase diagrams and kinetics

If these terms are fuzzy to you, review your course notes. If they are totally unfamiliar, beware…

Software

We will use a software for quantitative image analysis.

You will also use Microsoft Word to write up your assignments. Learn how to use the equation editor in Word and how to format documents.

Web Site

This course uses the Blackboard system; the web site is

Users – Structure of Crystals and Diffraction (scupi.cn)

(Note: the **https** is important, otherwise it may not load.) There you will find the course syllabus, homework assignments, and other materials. Current announcements and assignments will be posted on the home page. All assignments will be uploaded through the Blackboard system. Please check the class page frequently.

Class Format

This course is taught using a combined lecture, reading, review and discussion format. The class in the afternoon begins with two session lecture to review material in the literature and introduce new concepts. In the third session, the lecturer may ask questions to as many students as possible and encouraging critical reading of published papers in related field.

It is imperative that you come to class prepared. This will generally involve reading all posted literature and viewing tutorial videos. This is a three credit hour class, which means you should expect to devote at least 9 to 12 hours of effort outside the scheduled class time every week.

Homework Assignments

Homework problems will be assigned every three week and posted on Blackboard. These are to be completed and turned in by **Tuesday 1:30 PM** the following week. You may work with other people on homework, but all writeups must be individual efforts. Homework will be graded on a 0-100 point scale.

All work will be submitted electronically through the Blackboard system. Late homework will not be accepted.

Unless specifically requested, emailed homework will not be accepted.

Please adhere to these homework guidelines:

- Your assignment must be typeset using Word and submitted electronically through Blackboard. Handwritten assignments will not be accepted.
- Put your name, ID number (last four digits), and class section at the top of the first page.
- List the names of other people you've worked with on the assignment or report.

All of the homework scores will be used in your grade computation. Unless otherwise indicated, you can work with your fellow classmates in the class, but you must submit a distinct and independent write-up to receive credit.

If you're sick, or have a compelling emergency that prevents you from turning in the homework on time, email Prof. Charles Hua.

If you believe an error has been made in the grading of an assignment, bring it to the attention of your TA within ONE WEEK of its return.

Grading

Your grade will be based on the in-class Q/A (10%) and homework (30%), mid-term (30) and final exam (30%).

Office Hours

If you don't understand something, and talking to your classmates doesn't help, then you should be seeking help from the instructor or teaching assistant.

Office hours are times we have specifically set aside to be available to students. During office hours, you can come to our office; you don't need an appointment. We are also available at other times; please email to schedule a time.

Current office hours will be Wednesday 2-5 pm, Zone 3 – 322B.

Course Goals

After this lecture session the students will be able to…

1. Define the central theme of this lecture course.
2. Describe the policies regarding grading and other conduct and procedures for this lecture course.
3. Describe what the multidisciplinary field of Materials Science and Engineering is.
4. List the four states of matter and different structural states of condensed phases.
5. Discuss examples of how structure in addition to chemical composition of an engineered material affects properties and performance in applications.
6. Differentiate between long range and short range order as it relates to the description of the structure of materials.
7. Define the differences between non-crystalline and crystalline materials in terms of suitable descriptors.
8. List symmetry properties and use of them to describe structure of crystals.
9. List several basic descriptors suitable for discussion of the structure of materials.