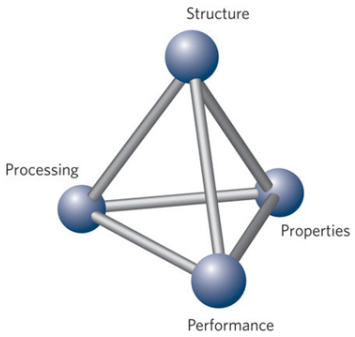
MSE 3101
Materials Science Investigations: Characterization
Spring 2025
Lecture: Jesser Hall, Room 171
Lab: Jesser Hall and Wilsdorf Hall, Default Room WDF 103*
*Lab rooms may vary in a given week and will be announced in the Monday Lectures



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Lecture: M W, 1:00-1:50 pm
Office Hours: W, 2:00-3:30 pm
Lab: Two hours/week, participation in one section required in a group of less than 6 students. **Sections will have to be shuffled and lab sections may be eliminated** to ensure students get into an appropriately sized-group (3-4 people is best)

Section 1: Tu 10:00 am
Section 2: Tu 1:00 pm
Section 3: Tu 3:00 pm
Section 4: W 10:00 am
Section 5: Th 1:00 pm
Section 6: Th 3:30 pm

Prerequisite: MSE 2090

Course Content: Material performance is governed by the composition, phases present, crystal structure, and microstructure. In this course, we will explore the most common characterization techniques to identify these features and then tie them back to material properties. You will understand the theory and application of inorganic materials preparation and characterization techniques including light microscopy (LM), scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), and x-ray diffraction analysis (XRD). Furthermore, skills for reporting data collected by these techniques in written and oral form will be developed.

Course Objectives (COs):
By the end of the semester, you will be able to:

1. Understand the theory and operation of materials preparation and characterization techniques, including Light Microscopy, SEM/EDS, and X-ray Diffraction for inorganic materials (CO1).
2. Relate materials characterization to materials science principles of structure, processing, and properties (CO2).
3. Communicate technical information in writing (CO3)
4. Communicate technical information verbally (CO4)

Required textbook:
Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition, Yeng Leng, ISBN: 978-3-527-33463-6

Hardcopy Available: Amazon or Bookfinder.com

Free Availability via UVA Library (must be on grounds or via VPN):
https://onlinelibrary.wiley.com/doi/book/10.1002/9783527670772

Other Online Resources (must be on UVA grounds or VPN to access most of these):

- Metallography - Principles and Practice ASM International, Vander Voort, George F. (1999).
  - https://app.knovel.com/kn/resources/kpMPP00011/toc
- ICSD Database: https://icsd.fiz-karlsruhe.de/search/basic.xhtml
- Metal Phase Diagram Database: https://matdata.asminternational.org/apd/index.aspx
- Ceramic Phase Diagram Database: https://phaseonline.ceramics.org/ped_figure_search/start_instructions
- NIST Monte Carlo Software: https://www.nist.gov/services-resources/software/nist-dtsa-ii
- NIH ImageJ: https://imagej.net/ij/

Required lab supplies:

1. Bring a notebook to lab sections to record any and all details of procedures followed, equipment used, deviations from normal procedures, observations, etc.
2. Lab objectives handout (includes details of objectives, list of data to be obtained, results and discussion points required for the lab reports, followed by detailed procedures)

Other resources:
Selected material will be uploaded to Course Canvas website including:

- Lecture notes as .pdf, before class
- Supplementary literature sections:
  - Metallography: Principles and Practice, George F. Vander Voort, ASM International, 1999.
  - Scanning Electron Microscopy and X-ray Microanalysis, 4th Ed., J. I. Goldstein, et al., Springer, 2018.
  - Elements of X-ray Diffraction, B.D. Cullity, Addison-Wesley Publishing Company, Inc., 1956.
- Laboratory procedures for Labs A, B, C

- Lab objectives for Labs A, B, C
- Instructions for Laboratory Report preparation
- Instructions for Technical Presentation preparation

Organization of Lectures with Respect to Textbook Chapters:

Chapter 1. Light Microscopy
Chapter 4. Scanning Electron Microscopy
Chapter 6. X-ray Spectroscopy for Elemental Analysis
Chapter 2. X-ray Diffraction

Organization of Laboratory Sessions (Due Dates of Reports Subject to Change):

Lab A1. Sample preparation	Week of January 19
Lab A2. Sample etching and optical microscopy	Week of January 26
Lab A3. Optical microscopy and hardness testing	Week of February 2
Group project	Week of February 9
Group project	Week of February 16
Lab Report A	Due February 26 at Lecture Time
Lab B4. Scanning electron microscopy, backscattered electron imaging	Week of February 23
Lab B5. Scanning electron microscopy, secondary electron imaging	Week of March 2
Lab B6. Scanning electron microscopy, energy dispersive spectroscopy	Week of March 16
Group project	Week of March 23
Lab Report B	Due April 7 at Lecture Time
Lab C7. X-ray diffraction phase identification	Week of March 30
Lab C8. X-ray diffraction semi-quantitative phase analysis	Week of April 6
Lab Report C	Due April 25 at 1:00 PM
Group project	All remaining lab sessions
Materials Science Investigation Symposium – Group Project Presentations	May 5, 9-12 am (Final exam time)

Grading:

Participation and Attendance	5%	
Lab report A	10%	
Lab report B	10%	
Lab report C	10%	
Project presentation	20%	(15% Group Grade + 5% Individual Contribution)
Homework	15%	
Exam 1: Light microscopy	10%	
Exam 2: Scanning Electron Microscopy	10%	
Exam 3: X-ray Diffraction	10%	

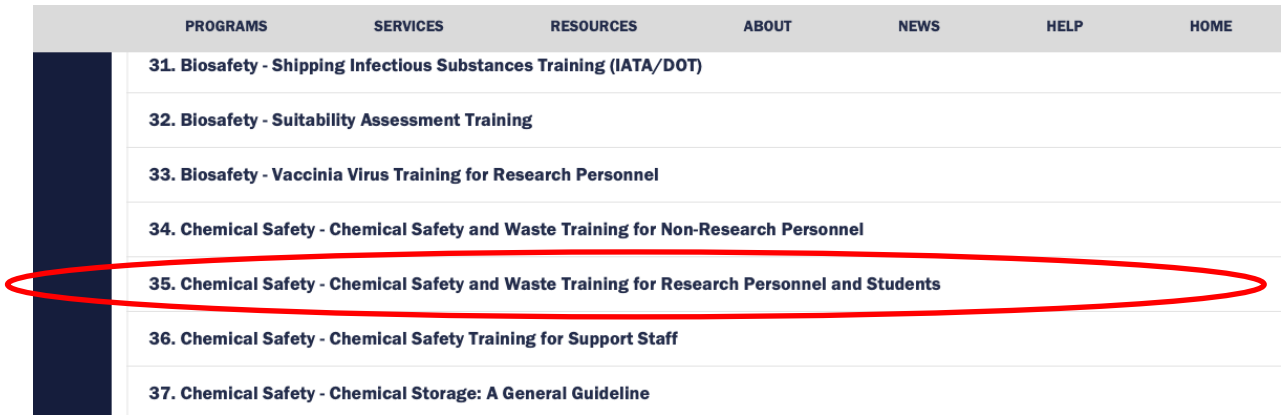
Lab Report Due Dates are subject to change.

Course Policies:

- Late homework will not be accepted.

- Late lab reports will have grades reduced by 10 points (out of 100) each day late. Extensions are not allowed.
- Exams may be comprehensive.
- Lectures will be recorded. This is for your convenience in the event that you are ill or have a legitimate excuse not to attend only. Class attendance is expected and lab attendance and participation are required.

Lab Safety:
All students must complete UVA's online Chemical Safety and Waste Training for Research Personnel & Students prior to participating in Lab A1 (takes ~60 minutes):
https://researchcompliance.web.virginia.edu/training_html5/Modules-EHS.cfm



Upload confirmation email to Canvas via the Assignments Portal.

All students must ***also*** turn in a signed acknowledgement form (available on Canvas) prior to participating in Lab A1.

Group Materials Science Investigation Project:
Each laboratory group will present a 25 minute conference style presentation (+5 minutes for questions). This presentation will be in lieu of a final exam and will be a part of the Materials Science Investigation Symposium, 9-12 AM, May 5, 2025. The symposium will be open to the public.

Each laboratory group will select a project material/widget to investigate using skills learned in the laboratory activities.

Use of Generative Artificial Intelligence Tools
I strongly discourage use of generative AI tools in coursework and lab reports. There are numerous cases of AI tools creating their own citations and incorrect statements. Lab reports are to demonstrate *your* understanding of the technique and application, not some electrons in a semiconductor's synthesized understanding. Your reports are being graded based upon what is submitted. If AI tools produce incorrect statements, points will be deducted

Honor
I trust every student in this course to fully comply with all of the provisions of the University's Honor Code. By enrolling in this course, you have agreed to abide by and uphold the Honor System of the University of Virginia, as well as the policies specific to this course. Honor Pledge: "On my honor as a student, I have neither given nor received aid on this assignment/exam." https://honor.virginia.edu/

Accessibility
The University of Virginia strives to provide accessibility to all students. If you require an accommodation to fully access this course, please contact the Student Disability Access Center (SDAC) at 434-243-5180 or sdac@virginia.edu. If you are unsure if you require an accommodation, or to learn more about their services, you may contact the SDAC at the number above or by visiting their website at https://sdac.studenthealth.virginia.edu/. Please contact me outside of class to explore options if you require an accommodation.

Well-Being
MSE serves as a safe space for its students and aims to promote their wellbeing. If you are feeling overwhelmed, stressed, or isolated, the Student Health Center offers Counseling and Psychological Services (CAPS) for students. Call 434-243-5150 (or 434-972-7004 for after hours and weekend crisis assistance) to get started and schedule an appointment. https://www.studenthealth.virginia.edu/caps

In addition to these resources, the School of Engineering and Applied Science has three staff members located in Thornton Hall who you can contact to help manage academic or personal challenges.

- Lisa Lampe, Assistant Dean for Undergraduate Affairs (academic), ll4uu@virginia.edu
- Georgina Nembhard, Director of Undergraduate Success (academic), gnembhard@virginia.edu
- Assistant Dean of Students (non-academic issues), CASS@virginia.edu

In addition to having an Assistant Dean of Students embedded in Engineering, we are also fortunate to have two CAPS counsellors embedded in our School. You may schedule time with Elizabeth Ramirez-

Weaver or Katie Fowler through Student Health (https://www.studenthealth.virginia.edu/getting-started-caps). When scheduling, be sure to specify that you are an Engineering student.

Discrimination and Power-Based Violence Prevention

The University of Virginia is dedicated to providing a safe and equitable learning environment for all students. To that end, it is vital that you know two values that I and the University hold as critically important:

1. Power-based personal violence will not be tolerated.
2. Everyone has a responsibility to do their part to maintain a safe community on Grounds.

If you or someone you know has been affected by power-based personal violence, more information can be found on the UVA Sexual Violence website that describes reporting options and resources available - https://cavcare.virginia.edu
https://justreportit.virginia.edu

Religious accommodations

It is the University's long-standing policy and practice to reasonably accommodate students so that they do not experience an adverse academic consequence when sincerely held religious beliefs or observances conflict with academic requirements. Students who wish to request academic accommodation for a religious observance should submit their request in writing directly to me by email as far in advance as possible. Students and instructors who have questions or concerns about academic accommodations for religious observance or religious beliefs may contact the University's Office for Equal Opportunity and Civil Rights (EOCR) at UVAEOCR@virginia.edu or 434-924-3200. Accommodations do not relieve you of the responsibility for completion of any part of the coursework missed as the result of a religious observance.
https://eocr.virginia.edu/accommodations/religious-accommodations