## Chemistry 5210 Materials Characterization Spring 2023 1:25–3:20 pm Mondays/Wednesdays Smith 111

Instructor: Andreas Stein; 219 Smith; 612-624-1802, <u>a-stein@umn.edu</u>, <u>http://stein.chem.umn.edu</u> Office hours: Mon 3:30–4:30 pm, Tue 12:15–1:15 pm; or by appointment.

 TA:
 Zahra Domin; 386 Kolthoff; 612-625-3098

 Office hours: Wed 8:00–9:00 am, Thu 8:00–9:00 am
 (Over Zoom: https://umn.zoom.us/j/8286440089)

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The Course: This course is scheduled as an in-person course. I intend to hold all class sessions in-person except if situational factors arise, such as personal illness of the instructor, when the class may be held synchronously via Zoom or recorded for later viewing. This course surveys a range of techniques suitable for characterization of solid-state materials, with an emphasis on techniques available at the University of Minnesota Characterization Facility, the Nanofabrication Center, and in the Department of Chemistry. The techniques discussed will include diffraction methods (powder X-ray diffraction, small-angle X-ray scattering, grazing-incidence small-angle X-ray scattering, neutron diffraction, electron diffraction), imaging techniques (scanning electron microscopy, transmission electron microscopy, atomic force microscopy and other surface probe microscopies), selected spectroscopic techniques relevant to materials (X-ray absorption techniques, X-ray photoelectron spectroscopy, surface-enhanced Raman spectroscopy, ellipsometry), thermal analysis (thermogravimetric analysis and differential scanning calorimetry), and pore analysis (gas sorption techniques). Throughout the course, we will address the following questions: Which technique is appropriate for what kind of material and for which property of the material? What information can you get from the technique? How does the technique work? What is the quality of the data (resolution, sensitivity, matrix effects, amounts of sample, fraction of material sampled, cost, availability) and how can it be optimized? What are the limitations of the techniques? Pitfalls? What are the sample requirements? This information will be supplemented by examples from current literature. We will also visit the Characterization Facility to see available equipment.

**Readings:** There is no required textbook. We will rely heavily on several excellent websites (listed below) and on current primary and secondary literature. Students should read assigned materials in advance, so that they can be discussed during the lectures.

https://myscope.training/ (also includes some simulators) https://jascoinc.com/learning-center/theory/spectroscopy/ https://www.eag.com/techniques/ https://www.jawoollam.com/resources/ellipsometry-tutorial https://www.doitpoms.ac.uk/tlplib/crystallography3/index.php https://www.doitpoms.ac.uk/tlplib/diffraction/index.php https://www.doitpoms.ac.uk/tlplib/miller\_indices/index.php https://www.doitpoms.ac.uk/tlplib/xray-diffraction/index.php https://www.doitpoms.ac.uk/tlplib/tem/index.php https://www.doitpoms.ac.uk/tlplib/tem/index.php https://www.doitpoms.ac.uk/tlplib/tem/index.php https://www.doitpoms.ac.uk/tlplib/afm/index.php https://www.doitpoms.ac.uk/tlplib/raman/index.php https://www.doitpoms.ac.uk/tlplib/raman/index.php **Course Web Page:** The course Canvas site will be used for posting the syllabus, lecture notes, grades, and other course-related material. Please ignore any letter grades listed on the Canvas site. These are automatically generated by Canvas but will not be used during the course.

**Clickers:** Clickers will be used for in-class responses. The required device is the iClicker2, and I will lend these to you. You must properly register your clicker to receive credit. Registration is done through the course Canvas site. On the Canvas page for CHEM 5210, click on the entry with the title "iClicker registration" on the left-hand side bar and follow the instructions.

**Course software:** During the diffraction component of the course, we will use CrystalMaker software and the associated programs CrystalDiffract and SingleCrystal to visualize structures and their diffraction patterns. This software will also be needed for some of the homework assignments. The Chemistry Department has a software license for these programs for students in Chem 5210 (both Mac and Windows). You will need to download the program files and manuals using the following link:

<u>https://drive.google.com/drive/folders/1zjRP7iBk7QAkbGfhPUiCaBJQnRZZXfC1?usp=sharing</u> You have to have to sign in with your U of M Gmail account when you access this folder on Google Drive.

The Rietveld refinement program FullProf with examples can be downloaded from the following website: <u>https://www.ill.eu/sites/fullprof/index.html</u>

## Grading:

Quizzes and class participation:	10 %
Assignments:	20 %
Group presentation:	20 %
Midterm exam 1* (Monday, Feb. 20, 1:25–3:20 p.m.):	16 %
Midterm exam 2* (Monday, Apr. 3, 1:25–3:20 p.m.):	16 %
Final exam (Friday, May 5, 10:30 a.m12:30 p.m.):	18 %

\*These exam dates are tentative and may be changed, if necessary, but they will be during class time.

During the course, all grades will be scored on a percentage basis. *Final letter grades* will be assigned based on the overall cumulative score. The following cut-offs will be used for letter grades: A:>87%

A-: >85% B+: >82% B: >72% B-: >67% C+: >62% C: >55% C-: >50%

Note that at the end, I may opt to adjust these cutoffs such that it will be possible to get a particular letter grade with a score that is lower than the range indicated above. But in no case will this adjustment hurt your grade. That is to say, *any adjustments, if applied, will only be used to improve your grade, not lower it.* 

If you are registered for this course on an S/N basis, a grade equivalent to C- or better on the A–F scale will be required to receive an "S". A D+ or below will receive an "N". Many programs or

transfer courses do not like S/N grades or will assume that they are the minimum possible grade. Requests to change grading basis after the University deadline will not be approved. An *I* grade will be assigned only to students who have received passing grades on all work up to the final exam. If this occurs, you are responsible for contacting me before the end of finals week. Otherwise, a grade of F will be entered on the grade report.

The Disability Resource Center (DRC, <u>https://disability.umn.edu/</u>) continues to hold all appointments and meetings remotely by phone or video conference (Zoom or Google Hangout). If you need to use the DRC, please contact DRC AS SOON AS POSSIBLE, to ensure your accommodations are in place at the beginning of the semester. You can do this by emailing <u>drc@umn.edu</u> or calling and leaving a message at 612-626-1333. If you already have an assigned access consultant and need modifications, please contact that person via email to address new access issues.

University-wide **policies** on the following topics

- Student Conduct Code
- Use of Personal Electronic Devices in the Classroom
- Scholastic Dishonesty
- Makeup Work for Legitimate Absences
- Appropriate Student Use of Class Notes and Course Materials
- Grading and Transcripts
- Sexual Harassment
- Equity, Diversity, Equal Opportunity, and Affirmative Action
- Disability Accommodations
- Mental Health and Stress Management
- Academic Freedom and Responsibility

can be found at this webpage: https://policy.umn.edu/education/syllabusrequirements-appa

**Important:** In this course, you will have access to electronic material, including lecture notes, assignments, examinations, solution sets, video recordings of lectures etc. You are NOT ALLOWED to share this material with anyone who is not currently enrolled in this class and you are NOT ALLOWED to upload any of this material to any website, including but not limited to online "study sites" at any time (even after this course is finished). Violation of this rule constitutes a violation of the Student Conduct Code.

You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using course materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, misrepresenting or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. If it is determined that a student has cheated, the student may be given an "F" or an "N" for the course, and may face additional sanctions from the University.