

## MATERIALS 4G03

# Characterization of Nanomaterials

**Instructor:** Bita Pourbahari [pourbahb@mcmaster.ca](mailto:pourbahb@mcmaster.ca)

**Course Schedule:** September 13-December 6 2021, Mondays, 7-10 pm EST

**Teaching Assistant (TA):** Jingyi Qu – [quj13@mcmaster.ca](mailto:quj13@mcmaster.ca)

**Office hours:** By email request

---

### Online Navigation

This course will be navigated through Avenue to Learn and Microsoft Teams. It is the student's responsibility to check their McMaster email and consult announcements made through these platforms on a regular basis; announcements posted on Microsoft Teams can be found under the "General" channel. Such announcements might include corrections, time changes and other updates. The instructor reserves the right to make any changes throughout the course.

### Lecture

Live, online lectures will be conducted through Microsoft Teams. Lectures will be recorded and posted shortly afterwards on Teams, Microsoft stream and Avenue. Recordings and lecture slides will remain available for the duration of the course, meaning you can access them anytime at your own convenience.

### Textbook

There is no mandatory textbook required for this course.

A list of recommended textbooks and readings:

Goldstein, J. I., Newbury, D. E., Michael, J. R., Ritchie, N. W., Scott, J. H. J., & Joy, D. C. (2017). *"Scanning electron microscopy and X-ray microanalysis"*. Springer. 4th edition

Hofmann, S. (2012). *"Auger-and X-ray photoelectron spectroscopy in materials science: a user-oriented guide"* (Vol. 49). Springer Science & Business Media.

Brown, P. D. (1999). *"Transmission Electron Microscopy-A Textbook for Materials Science"*, by David B. Williams and C. Barry Carter. *Microscopy and Microanalysis*, 5(6), 452-453.

Newville, M. (2014). *"Fundamentals of XAFS. Reviews in Mineralogy and Geochemistry,"* 78(1), 33-74.

### Evaluation:

**Assignments (20%):** There will be an assignment at the end of each lecture (except first lecture) (Total = 8 assignments). Assignment will be posted on Avenue. Assignments will be due by the beginning of the next lecture time with online submission on Avenue. There will be penalties for lateness (MSAF for deadlines missed)

$$(1-0.1*\text{number of full days overdue})$$

For example: The assignment graded as 80% with 2 days overdue will receive

$$80%*(1-0.1*2) = 64%$$

**Final project (30%):** Each student will prepare a 10-minute presentation and 3 page minimum written report at the end of the term. The report must 1) have 1" margins on letter size paper, 2) have a maximum line spacing of 2, 3) have a maximum of 4 figures (excludes equations), with a height limit of 2.5" each. A guideline will be posted describing key points that needs to be addressed in your project. Your topic must be **approved** by the instructor by **Nov. 1**. This means your topic must be submitted well in advance! If you have not received my approval by this date, a topic will be chosen and assigned to you. You may choose from a list of pre-approved topics or suggest your own. A schedule will be posted on **Nov. 2** to reserve your presentation timeslot. Please reserve your timeslot ASAP so that you can make changes to your schedule well in advance.

**Mid-term exam (20%):** The midterm exam will be on the lecture covering concepts taught to end of the lecture class.

**Final exam (30%):** The final will be cumulative, meaning it will encompass all material discussed in the course. It will take place during final exam week.

## Basic timeline for the course

- **Week 1 (Sept. 13):** Introduction to nanomaterials/ Interaction of electrons with matter
- **Week 2 (Sept. 20):** Scanning Electron Microscopy (SEM)
- **Week 3 (Sept. 27):** Auger spectroscopy (AES)/ Energy dispersive spectroscopy (EDS)
- **Week 4 (Oct. 4):** Scanning Transmission Electron Microscopy (STEM)
- **Week 5 (Oct. 11):** Reading Week
- **Week 6 (Oct. 18):** Transmission Electron Microscopy (TEM)/ Electron Energy Loss Spectroscopy (EELS)
- **Week 7 (Oct. 25):** Midterm
- **Week 8 (Nov. 1):** Focused Ion Beam Microscopy (FIB)/ Atom Probe Tomography (APT)
- **Week 9 (Nov. 8):** Scanning Probe Microscopy (SPM)
- **Week 10 (Nov. 15):** X-Ray Absorption Spectroscopy (XAS/XAFS)/ X-Ray Photoelectron Spectroscopy (XPS)
- **Week 11 (Nov. 22):** Scanning Transmission X-Ray Microscopy (STXM)/ Raman Spectroscopy
- **Week 12 (Nov. 29):** Class Presentations
- **Week 13 (Dec. 6):** Class Presentations

## Course Objectives

By the end of this course, you should understand:

Common techniques used to characterize nanomaterials using imaging and spectroscopy techniques at high spatial resolution.

- Several of the most common techniques will be discussed
  - Interaction of radiation and electrons with matter
  - Common techniques used to characterize nanomaterials
  - Fundamentals behind each technique
  - Radiation sources
  - Instrumentation
  - Image Formation and Processing Techniques
  - Formation of spectra and data interpretation to extract chemical information
  - Advantages and disadvantages of each technique

## Ethics

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

You need to be familiar with the Statement on Academic Ethics and the Senate Resolutions on Academic Dishonesty. These documents are found in the Senate Policy Statements provided when you registered and are also available in the Senate Office. Any student who breaks these resolutions will be treated according to the published policy.

Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, specifically Appendix 3. Posting answers to assignment questions or detailed methods of solution is not acceptable on the Avenue message board, or on other social sites, e.g. Facebook.

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

### Academic Accommodation

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140, ext. 2865 or e-mail [sas@mcmaster.ca](mailto:sas@mcmaster.ca). For further information, consult McMaster University's Policy for Academic Accommodation of Students with Disabilities.

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

#### Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

#### Discrimination Policy

McMaster University is concerned with ensuring an environment that is free of all adverse discrimination. If you encounter a problem that cannot be resolved through discussing it with the people involved, please contact the Department Chair, the Sexual Harassment Office or the Human Rights Consultant, as soon as possible.