UNIVERSITY of GUELPH
College of Physical and Engineering Sciences
DEPARTMENT OF CHEMISTRY
Fall 2015
NANO*2000, Synthesis and Characterization I [0.5]

Prerequisite(s): CHEM*1050, (IPS*1510 or PHYS*1010 & MATH*1210)

Instructor:	Dr. Jay Leitch, SSC 2107, Ext. 56262, e-mail: leitchj@uoguelph.ca
Lab instructor:	Dr. Jay Leitch, SSC 2107, Ext. 56262, e-mail: leitchj@uoguelph.ca
Lecture:	Mon. & Wed. 13:00 – 14:20 Room: MCKN 233
Laboratory:	Thur. 14:30 – 17:20; SSC 2109/10
Final Exam:	Fri. 8:30 – 10:30; (2015/12/18) Room: TBA

Bibliography

There is no required textbook for NANO 2000. Readings will be identified for each topic and theme discussed in class. These reading materials and Class Notes will be available on CourseLink site.

Supplementary textbooks:
Hornyak, G. L. *Introduction to Nanoscience*. CRC Press: Boca Raton, FL, 2008
Lindsay, S. M. *Introduction to Nanoscience*. Oxford University Press: New York, NY, 2010

Office Hours

Office hours will be scheduled for Fridays 9:00 – 13:30. Other available appointments can be schedule via email. I will also be virtually available via email and I will do my best to answer all of your questions.

Context for Course

This course focuses on the synthesis and development of nanomaterials via top-down and bottom-up approaches. These methodologies include chemical vapor deposition (CVD), chemical etching, ion beam epitaxy, electrochemistry, photolithography, self-assembly, etc. In addition, the unique chemical and physical properties that arise due to these small length scales can be studied with a wide variety of advance analytical instrumentation. These techniques include atomic force microscopy (AFM), scanning electron microscopy (SEM), BET, X-ray diffraction, etc. Specific topics that will be discussed in the course are given in the table below.

Please note that the focus of this course is on techniques suitable for the synthesis and characterization of nanometric materials, some of the macroscopic aspects of the techniques will be left for the students to explore on their own time. Subject to the time available, NANO 2000 may not cover the complete list of topics and themes presented below.

Content of Lecture Series

Lecture	Content
1	Introduction to NANO*2000. Nanostructures in Nature, Nanogold and types of Nanostructures
2-3	Electron Microscopy: Topics include Electron Optics. Resolution. Numerical Aperture (N.A). Rayleigh. Abbe. Wave-Particle Duality. Electron Waves, de Broglie. Interaction of electrons with Solids. Secondary Electrons. Mean Free Paths. Scanning Electron Microscopy (SEM). Electron optics. EDX. X-Ray Fluorescence. X-Ray emission**.** Mosely. EDX examples. Transmission Electron Microscopy (TEM).
4-6	Scanning Probe Microscopy: atomic force microscopy and scanning tunneling microscopy (STM)
7-8	Top down methods for producing nanostructure materials
9-11	Bottom up methods for synthesizing nanomaterials
12-13	Carbon structures – Structures, Synthesis and Purification of Fullerenes, Growth Mechanisms
14-16	Introduction to x-ray crystallography: Miller indices, single crystal surfaces (related to STM), crystal structures, hkl planes, Bragg's law, XRD
17	Physical Chemistry of Nanostructures. Importance of Nanostructure Surface. Surface to Volume Ratios. Size and Shape, Bravais Lattices.
18	Bravais Lattices for cubic and hexagonal systems. Close Packing. Octahedral and tetrahedral vacancies. Packing Density. Structural magic Numbers. Hollow nanostructures.
19	Size-dependent properties of nanostructures. Melting Points. Lattice Energies. Madelung Constants and nanostructures. Ewald's Method. Madelung series for various structures as function of size. Surface Madelung Constants.
20-21	BET theory, isotherms and examples. Mercury Porosimetry. Dynamic Light Scattering (DLS), Quartz Crystal Microbalance
22	Review

Evaluations

1) Mechanisms	2 assignments, a review paper, laboratory work, a mid-term and final exam
2) Weighting	Assignments – 10% (5% each)
	Review Paper – 15%
	Laboratory – 30%
	Mid-term – 20% (in-class, date - TBA)
	Final Exam – 25% (Dec. 18, 8h30-10h30)

Note: In order to pass NANO2000, the student must receive passing grades on both the laboratory and the lecture. Students who do not pass both components will receive a maximum grade of 48% for the course.

A Note Concerning Assignments

An important aspect of the course is a series of assignments that assess the students' understanding of the material.

The due date and time for each assignment will be clearly identified. Submissions will not be accepted after this deadline. These assignments have to be completed individually by each student and either submitted by CourseLink Dropbox or handed-in to the course Instructor by the end of class on the due-date.

The solutions to these problems will be posted to the course web site as soon as possible.

University regulations

E-mail Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. See the undergraduate calendar for information on regulations and procedures for Academic Consideration.

Drop Date

The last date to drop one-semester courses, without academic penalty, is Friday, November 6. For regulations and procedures for Dropping Courses, see the Undergraduate Calendar.

Copies of out-of-class assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's

shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Student Accessibility Services as soon as possible.
For more information, contact ASA at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.
The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.