Course Outline

MATLS 4FF03 – Synthesis, Applications and Env. Impact of Nanomaterials
Term II 2017-2018

Classroom	:	T13, Room 106
Time	:	Tuesdays (14:30), Thursdays (14:30), Fridays (14:30)
Instructor	:	Gianluigi Botton (gbotton@mcmaster.ca)
Guests lecturers	:	Invited researchers working in the area of nanofabrication/synthesis/applications
TA	:	Viktor Kapetanovic, (KAPETAV@MCMASTER.CA)

Course Objectives:
The course aims to provide the necessary knowledge of synthesis methods, properties and wide-range of applications of various nanoscale materials and understand the impact of these materials on the environment and health of users and stake holders (producers, manufacturing workers).

Course Outcomes:
At the end of the course, students are expected to show the ability to:

- Understand the fundamentals and unique origins of nano-scale phenomena.
- Understand the main synthesis techniques available to produce nanoscale materials.
- Select the tools and synthesis techniques are most suitable for a given application, including characterization techniques.
- Assess the environmental and health impact of these nanomaterials for the end users (e.g. toxicity) and for the manufacturing process (synthesis methods that are more environmentally friendly and less toxic during production and more sustainable).
- Analyse the literature resources to assess wide range of information related to synthesis, applications and environmental impact of nanomaterials.
- Work effectively in teams and communicate effectively the findings on short projects through written work and brief group presentation to the class.

MATLS 4FF03 is an important part of your training as an engineer. In particular the course will allow you to:

(1) Gain Specialized Engineering Knowledge including:
(a) Why nanoscale phenomena occur.
(b) The main synthesis methods to produce nanoscale materials.
(c) Assess the impact of nanomaterials on health and environment

(2) Use modern state of the Art tools in order to:
(d) Select the appropriate synthesis (zero-D, 1-D, 2-D and 3-D) method to produce a desired nanoscale material exhibiting specific desired electronic, optical, mechanical properties.

Course References:

Textbook:
Guozhong Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications, 2nd Edition. 2010 World Scientific Publishing Company, Incorporated, (ISBN: 9789814324557)

Website:
http://avenue.mcmaster.ca
for update about notes, assignments and announcements (check routinely!!)

Week #	Description
1	General Introduction ▫ Classification based on dimension and type ▫ Importance and challenges of scaling down to nano-scale ▫ Current and potential applications ▫ Physical chemistry of solid surfaces
2	Thermodynamics (Gibbs Energy) Bottom-up approach Synthesis of zero-, one-, and two-dimensional nanostructures ▫ Nanoparticles: homogeneous & heterogeneous nucleation ▫ Nanowires/rods: Spontaneous growth & Template synthesis ▫
3	Synthesis of one-dimensional nanostructures ▫ Nanowires/rods: Spontaneous growth & Template synthesis ▫
4	Synthesis of two-dimensional nanostructures (top down approach) ▫ Thin Films: PVD, CVD & ALD Self Assembly
5	Synthesis, continued. Carbon nanotubes: structure and applications (TBC)
6	Environmental and health impact of nanomaterials: green approaches to synthesis, environmental impact in air and water environments. Impact of living organisms, mechanisms of cytotoxicity. Laboratory demonstration of colloidal gold nanoparticle synthesis
7	**Reading Week (Feb 19 to 25)**
8-11	Mid term (tentative date: 2nd March) Fabrication of nanostructures by physical techniques Lithography, Assembly of nanoparticles/Wires Characterization of nanomaterials: Structural and chemical Properties of nanomaterials ▫ Physical: thermodynamics, mechanical, optical, quantum size effects Electrical & magnetic: conductivity, ferroelectricity, superparamagnetism Mechanical properties of nanocrystalline materials Synthesis – Characterization – Integration –Product / Devices Applications of nanomaterials ▫ Electronics: Molecular electronics, Bandgap Engineering ▫ Photoelectrochemical, Photonic Crystals, Waveguides Biological applications of nanoparticles, sensing
12-14	Presentation of projects & report submission

This schedule is tentative and subject to change depending on the progress of the class. The laboratory session on the synthesis of nanoparticles may be moved to a different week pending availability of the laboratory.

To ensure long-term learning, student participation and interaction are important not only in class but outside class hours. It is hoped that students will learn from a variety of sources (books, scientific journals, internet, and other students' presentations) and interact with peers.

ASSESSMENT:

Project proposal (5%), class and lab attendance and participation (5%)	10%
Mid-term Test	20%
Presentations and written work Topics selected in consultation with instructors	30%
Final exam This will assess the covered material in the lectures and the student presentations	40%

Written work will have to be submitted in hard copy and in electronic form for verification of originality (see policy on Academic dishonesty below). Plagiarism from any sources (internet, books, scientific articles etc.) and on any form (written work, presentations in class, assignments) will not be tolerated.

POLICY REMINDERS:

Senate and the Faculty of Engineering require all course outlines to include the following reminders:
The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem that cannot be resolved by discussion among the persons involved, individual are reminded that they should contact the Department Chair, the Sexual Harassment Office or the Human Rights Consultant, as soon as possible. Students should be reminded that they should read and comply with the "Statement on Academic Ethics and the Senate Resolution on Academic Dishonesty" as found in the Senate Policy Statements distributed at registration and available in the Senate Office.
http://www.mcmaster.ca/senate/academic/academic.htm