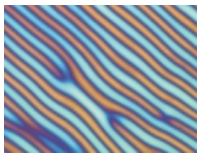

NANO*3500 Thin Film Science Fall 2017
Course Outline

This course introduces nanoscience students to concepts that are central to the study of thin films, surfaces and interfaces. Following an introduction to liquid and solid surfaces, fundamental forces acting at interfaces and basic surface thermodynamics are discussed. This leads to a discussion of different deposition techniques, characterization techniques and instabilities that are inherent to thin films. There is a laboratory component to the course that complements the material discussed in lectures and allows the students to become proficient on a broad range of surface-sensitive equipment.

Lecturer:

Professor John Dutcher, MacN 451, ext 53950, dutcher@uoguelph.ca

John's research focuses on developing a fundamental understanding and predictive power for the physical properties of polymers, biopolymers and bacterial cells at surfaces and in thin films. He applies a broad range of surface-sensitive experimental techniques and fundamental, physics-based strategies to develop simple models of these complex soft matter systems. For more information, visit the Dutcher Lab webpage.

Lectures:

Monday, Wednesday, Friday; 11:30 – 12:20; CRSC 403

Labs:

Tuesday; 11:30 – 14:20; SSC 2109/2110

Calendar Description:

The deposition and growth of thin layers of materials is an important process on the production of many devices. This course will study the various methods by which thin films are grown including physical and chemical vapour deposition, molecular beam epitaxy, atomic layer epitaxy, and self-assembled monolayers. Experimental techniques for analyzing the properties of thin films will also be discussed.

Prerequisites:

NANO*2100 Analysis of Nanomaterials

Required Textbook:

H.-J. Butt, K. Graf and M. Kappl, *Physics and Chemistry of Interfaces*, Third Edition (Wiley-VCH, 2013))

Course Topics:

<u>Surfaces</u>

- liquid versus solid surfaces
- surface tension
- wetting of surfaces
    - contact angle
- surface and interfacial forces
    - van der Waals forces
    - electrical double layer
- adsorption onto surfaces
    - surface thermodynamics
    - surface isotherms

<u>Thin Films</u>

- deposition techniques
    - vacuum deposition
    - chemical vapour deposition
    - spincoating
    - self-assembly

    - Langmuir-Blodgett deposition
- thin film instabilities
- thin film characterization techniques
- other topics
- review

Course Learning Objectives:

This course will use a multidisciplinary approach to present new concepts and build on concepts covered in previous physics, chemistry and nanoscience courses. The objectives of this course are:

1) Introduce physical concepts and mathematical tools used to describe surfaces, interfaces and thin films
    - Develop an intuition for surface and thin film physical principles through plotting of functions using Maple

2) Relate the mathematical results to practical applications and experiments
    - Develop an appreciation of the mathematical basis for experimental techniques for deposition and analysis of thin films

3) Understand physical phenomena that can be exploited for the deposition of thin films
    - Demonstrate knowledge of different thin film deposition strategies

4) Develop proficiency for experimental techniques used to deposit and characterize thin films
    - Demonstrate laboratory and data analysis skills

5) Expand scientific writing skills to develop effective communication
    - Develop ability to analyze and synthesize implications of key results of published scientific studies

Evaluation:

Assessment	Weight
Assignments	15%
Report on Research Paper	10%
Midterm Test (Oct 25, 19:00-21:00)	20%
Final Examination (Dec 15, 19:00-21:00)	30%
Laboratory Performance and Reports	25%
Total	**100%**

The assignments and the report on the research paper are due at the beginning of class on the due date. Unless there are exceptional circumstances, marks will be deducted for lateness (10% per day). Marks will also be deducted for errors in English grammar and spelling in all work submitted for grading. Students must obtain a final grade of 50% to pass the course.

If you request academic consideration due to illness of a physical, psychological or emotional nature, or due to compassionate reasons, you may be required to provide suitable documentation (e.g., a medical certificate from a physician) at the discretion of the lecturer. See the undergraduate calendar for information on regulations and procedures for Academic Consideration.

CourseLink Page:

There is a NANO*3500 CourseLink page to allow you easy access to course-related material.

HELP!

Short questions can often be handled in the lecture room just before or after lectures. Hours will be announced when John is almost certain to be in his office for consultation with students. He will make every effort to answer emails in a timely manner.

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.

See the Undergraduate Calendar for information on the Academic Misconduct Policy.

Collaboration Versus Copying:

Scientists often consult fellow scientists to discuss their research problems. Collaboration between scientists is often essential to perform world-class research. However, no ethical scientist would ever publish or claim the work of others as his or her own. Instead, joint publication or acknowledgements of the contributions of their collaborators is given.

The work that you submit for marking must be your own and not a copy of someone else's work. As a young scientist, you are encouraged to discuss with your fellow students as you learn the material and work on your assignments and presentations. However, plagiarism is a form of academic misconduct, and will not be tolerated. In your work that you submit for marking, you are encouraged to cite references and acknowledge discussions with others who have helped you to achieve an understanding of the material. This is good scientific practice.

Student Assessment:

The Department of Physics requires student assessment of all courses taught by the Department. These assessments provide essential feedback to faculty on their teaching by identifying both strengths and possible areas of improvement. In addition, annual student assessment of teaching provides part of the information used by the Department Tenure and Promotion Committee in evaluating the faculty member's contribution in the area of teaching.

The Department's teaching evaluation questionnaire invites student response both through numerically quantifiable data, and written student comments. In conformity with University of Guelph Faculty Policy, the Department Tenure and Promotions Committee only considers comments signed by students (choosing "I agree" in question 14). Your instructor will see all signed and unsigned comments after final grades are submitted. Written student comments may also be used in support of a nomination for internal and external teaching awards.

No information will be passed on to the instructor until after the final grades have been submitted.

Note:

John may be away several times during the semester for research purposes. He will try to arrange that enthusiastic and talented replacement lecturers give lectures at the regular times. Otherwise, makeup lectures will be arranged at times that are agreeable to the students.