

The University of Western Ontario  
Department of Physics and Astronomy

Surface Science  
Physics 9826a  
Fall 2010

### Lectures

Monday, 10:30am-12:30pm, P&AB 232  
Wednesday, 10:30am-11:30am, P&AB 232

### Course Instructors

Dr. Lyudmila Goncharova  
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<http://www.physics.uwo.ca/~lgonchar>

### Guest Lectures:

Dr. Heng Y. Nie (SPM)  
Dr. François Lagugné-Labarthe (vibrational spectroscopies) and others (TBA).

### Course Description:

The purpose of the course is to acquaint students in physics, chemistry, materials science and engineering with static and dynamic behavior of solid surfaces and interfaces, from both theoretical and experimental points of view. Topics will include geometrical lattice structure, surface morphology, electronic structure, surface composition, kinetics and dynamics (adsorption, vibrations, diffusion, desorption), structure and reactivity of surface molecules, catalysis and surface reactions. Surfaces of metals, oxides, semiconductors will be considered, as well as solid-solid and solid liquid interfaces, and confinement effects in 2D, 1D and 0D cases. Modern experimental methods (ultra-high vacuum based, and in air) will be discussed: theoretical bases, experimental aspects and data interpretation. *Three lecture hours per week; half course; One term.*

**Web-site:** <http://www.physics.uwo.ca/~lgonchar/courses/p9826/index.shtml>

You will find details on the course outline, updates and supplementary material to the lecture notes and homework assignments on this web-site.

**Office hours:** by appointment; or you can drop-by after class.

### Textbooks

There will be no mandatory textbooks. Several textbooks will be used plus additional reading will be posted on the web-site:

1. Kurt W. Kolasinski, *Surface Science: Foundations of Catalysis and Nanoscience*. 2nd ed.; Wiley & Sons: Chichester, England; Hoboken, NJ, 2008; p 500.
2. A. Zangwill, *Physics at Surfaces*. Cambridge University Press: New York, 1988; p 472.
3. D.P. Woodruff, T.A. Delchar, *Modern Techniques of Surface Science*. 2nd ed.; Cambridge University Press: New York, 1994.
4. John C. Vickerman, *Surface Analysis - The Principal Techniques*. John Wiley: New York, 1997; p 474. (These books will be on reserve in the library.)

### Assignments and Grades

Course requirements will include 4 homework assignments (each of them contributes 10% of the grade). Since people usually "learn by doing," the homeworks are an extremely important part of the course experience. A little discussion among your classmates and looking through books is permitted and even encouraged, but the write-up must be your own work.

There will be a take-home midterm exam (30% of the grade), a final paper (20% of the grade, topics will be provided later) and presentation (10% of the grade). Assignments, topics and their deadlines will be posted on the web site.

Assignments and a final paper must be turned in at the requested day before 6pm. Penalty points may be applied, if you are late more than one time.

To assign the final mark certain adjustments may be made at the end, based on factors like class participation, to arrive at a final mark.

### Course topics with the tentative time line (see web site for more details)

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<b>Topic</b>
Introduction to course; why are surfaces interesting, thermodynamics of the surfaces and equilibrium crystal shape
Bulk and surface structure, relaxations, reconstructions, defects, 2D lattices
Physics of ultrahigh vacuum
Introduction to electronic properties, work function, thermionic emission, field emission
Thermodynamics and kinetics of adsorption and desorption, energy transfer, adsorption, desorption, diffusion, etc. <a href="#">HWA#1</a>
Electron mean free path, diffraction methods, microscopy principles of SEM
Photoemission spectroscopy – the physics of spectral peak position and intensity
Basic instrumentation and applications of XPS and UPS <a href="#">HWA#2</a>
More applications of XPS and UPS; Other electron spectroscopic techniques (synchrotron-radiation-based electron spectroscopy; Auger electron spectroscopy and scanning Auger microscopy)
<a href="#">Midterm Exam</a>
Physics of ion-surface interactions; ion scattering, recoiling and sputtering methods <a href="#">HWA#3</a>
Linear and Non-linear Vibration Spectroscopy
Scanning Probe Microscopy (AFM, STM) <a href="#">HWA#4</a>
Band Structure: bulk, film, surface; and their measurements
<a href="#">SSW Lab tour and demonstration (XPS; TOF-SIMS; AFM/STM)</a>
Heterogeneous Catalysis
<a href="#">Final Paper is due</a>
Nucleation and growth of nanostructures and films
Quantum confinement effects
<a href="#">Final Paper presentations</a>

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### Resources

Other Reference Books and Materials:

5. John T. Yates, *Experimental innovations in surface science : a guide to practical laboratory methods and instruments*. Springer: New York, 1998; p 904
6. G. Attard, C. Barnes, *Surfaces* Oxford University Press: 1998; p 96.
7. D. Briggs, M.P. Seah, *Practical Surface Analysis*. 1991; Vol. 1.
8. Harald Ibach, *Physics of Surface and Interfaces*. Springer: Berlin, 2006.
9. Ch. Kittel, *Introduction to Solid State Physics*. John Wiley: New York, 1996.
10. H. Luth, *Solid surfaces, interfaces and thin films* Springer: Berlin; New York, 2001; p 559.
11. G.A. Somorjai, *Chemistry in two dimensions: surfaces*. Cornell Univ. Press: Ithaca 1881; p 575.

Some useful web sites are:

1. [http://www.phys.au.dk/~philip/q1\\_05/surflec/surflec.html](http://www.phys.au.dk/~philip/q1_05/surflec/surflec.html)
2. <http://venables.asu.edu/grad/lectures.html>

**Plagiarism:**

Scholastic offences are taken seriously and you are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

<http://www.uwo.ca/univsec/handbook/appeals/scholoff.pdf>

Students must write their assignments on their own. Students must acknowledge cited text by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).

A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Record's Release Form (located in the Dean's Office) for visits to Student Health Services. The form can be found here:

[https://studentservices.uwo.ca/secure/medical\\_document.pdf](https://studentservices.uwo.ca/secure/medical_document.pdf)

**Accessibility Statement**

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.