The University of Western Ontario
Department of Physics and Astronomy

Surface Science
Physics 9826
Winter 2009

Lectures
Tuesday and Wednesday 11:30 am - 13:00 pm, P&A room 106

Course Instructors
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http://www.uwo.ca/ssw/index.html

Guest Lectures:
Dr. François Lagugné-Labarthet (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. A. Zangwill, *Physics at Surfaces*. Cambridge University Press: New York, 1988; p 472.
2. Kurt W. Kolasinski, *Surface Science: Foundations of Catalysis and Nanoscience*. 2nd ed.; Wiley & Sons: Chichester, England; Hoboken, NJ, 2008; p 500.

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 5 homework assignments (each of them contributes 10% of the grade); analysis paper March (20%) and final examination (30% of the grade). Assignments and their deadlines will be posted on the web site.

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

Topic
Introduction to course; why are surface interesting, thermodynamics of the surfaces and equilibrium crystal shape
Bulk and surface structure, relaxations, reconstructions, defects, 2D lattices
Physics of ultrahigh vacuum HWA#1
Introduction to electronic properties, work function, thermionic emission, field emission
Thermodynamics and kinetics of adsorption and desorption, energy transfer, adsorption, desorption, diffusion, etc. HWA#2
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 HWA#3
More applications of XPS and UPS; Other electron spectroscopic techniques (synchrotron-radiation-based electron spectroscopy; Auger electron spectroscopy and scanning Auger microscopy)
Physics of ion-surface interactions; ion scattering, recoiling and sputtering methods HWA#4
Linear and Non-linear Vibration Spectroscopy
Scanning Probe Microscopy (AFM, STM) HWA#5
Band Structure: bulk, film, surface; and their measurements
SSW Lab tour and demonstration (XPS; TOF-SIMS; AFM/STM)
Heterogeneous Catalysis
Paper is due
Nucleation and growth of nanostructures and films
Quantum confinement effects
Final Exam

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. E. Kasper, D.J. Paul, *Silicon quantum integrated circuits: silicon-germanium heterostructures devices : basics and realizations*. Springer: Berlin; New York 2005; p 360

10. Ch. Kittel, *Introduction to Solid State Physics*. John Wiley: New York, 1996.
11. H. Luth, *Solid surfaces, interfaces and thin films* Springer: Berlin; New York, 2001; p 559.
12. R.I. Masel, *Principles of adsorption and reaction on solid surfaces*. Wiley: New York, 1996.
13. S. Roy Morrison, *The Chemical Physics of Surfaces*. Plenum Press: New York, 1977.
14. G.A. Somorjai, *Chemistry in two dimensions: surfaces*. Cornell University Press: Ithaca 1881; p 575.

Some useful web sites are:

1. 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