**4:238 Surface Chemistry and Heterogeneous Processes**

This course is intended as an introduction to surface chemistry and an overview of methods for the characterization of surfaces. This is a lecture-based course that will include projects involving surface measurements – BET measurements, scanning tunneling microscopy, atomic force microscopy, photoelectron spectroscopy and Auger electron spectroscopy.

**Instructor:**
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Office Hours: T Th 10:45 - noon or by appointment

**Department of Chemistry Contact Information:**
Main Office: 305 CB  
Phone: 335-0200  
Department Executive Officer: Mark Arnold

**Lectures:**  
T Th 9:30 - 10:45, C129 PC

**Textbook:**  
Surface Science Foundations of Catalysis and Nanoscience  
3rd Edition by Kurt W. Kolasinski

**Course website:**  
To access the course website go to http://icon.uiowa.edu/index.shtml

**Grading and Grading Criteria:**
Final Grades will use +/- designations  
Exam - 50% (Exam 1-March 12th 9:30 AM; Exam 2-Finals Week Day & Time TBA)  
Paper- 20%  
Presentation - 10%  
Problem Set - 20%

**Topics to be Discussed:**

1. **Adsorption** - physisorption; chemisorption; dissociative adsorption; gas-surface interactions; adsorption from solution; accommodation; energy exchange; isotherms; precursor states; $\Delta H_{ads}$; adsorbate-adsorbate interactions; potential energy curves.

2. **Desorption** - desorption kinetics; recombinative desorption; temperature-programmed desorption; Redhead analysis; activation energy of desorption; isothermal desorption; desorption dynamics and time-of-flight.

3. **Structure of Solid Surfaces** - Miller indices; low energy electron diffraction; surface reconstruction.

4. **Electronic Properties of Extended Structures** - free electron theory; band theory; density of states; surface states; work function
5. **Surface Analysis: Techniques and Methods** - pumping systems; ultra-high vacuum; Auger electron spectroscopy; photoelectron spectroscopy; scanning tunneling microscopy; atomic force microscopy; secondary ion mass spectrometry; second harmonic generation; sum frequency generation; laser-induced desorption; electron energy loss spectroscopy; reflectance IR spectroscopy.

6. **Chemical Bonding at Surfaces** - adsorption sites; orbital interactions; adsorbate orientation; adsorbate induced reconstruction; surface diffusion; organometallic-surface analogy; dangling bonds.

7. **Chemical Reactions at Surfaces** - kinetics and mechanisms of surface reactions; dissociation; coupling reactions; surface photochemistry.

8. **Catalysis** - heterogeneous and homogeneous; selectivity; promoters and inhibitors; coking; cracking catalysts; Langmuir-Hinshelwood mechanism; Ely-Rideal mechanism; supported catalysts; turnover; activity; hydrogenation; dehydrogenation; oxidation.

9. **Nanoscience and Nanotechnology** – sized dependent properties, enhanced surface activity on the nanoscale, nanoparticles in natural and engineered systems.

10. **Heterogeneous Processes in Atmospheric and Environmental Chemistry** - environmental catalysis, the role of heterogeneous chemistry in stratospheric ozone depletion, heterogeneous tropospheric processes; water-mineral interfacial chemistry

11. **Interfaces: Material and Biological Surfaces** - Langmuir-Blodgett films; self-assembled monolayers; lipid films; chemical vapor deposition; epitaxial growth of films.

**Further Considerations:**
*I would like to hear from anyone who has a disability which may require some modification of seating, testing, or other class requirements so that appropriate arrangements may be made. Please contact me during my office hours.*

**For each semester hour credit in the course, students should expect to spend at least two hours per week preparing for class sessions (averaged over the entire semester).**

***All course assignments must represent the independent work of students. Students with questions regarding the collegiate policy on plagiarism, cheating and academic (mis)conduct should consult the full policy in the Schedule of Courses and the College of Liberal Arts and Sciences Bulletin.***

****A student who has a complaint against any member of the CLAS teaching staff is responsible for following the procedures described in the Schedule of Courses. Any student who feels that Prof. Grassian has not adequately met the standards of oral communication competence or any other standards may contact the Department of Chemistry Executive Officer, Mark Arnold.***
Further Considerations and Information (continued):

**Administrative Home** The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall, or see the CLAS Student Academic Handbook.

**Electronic Communication** University policy specifies that students are responsible for all official correspondences sent to their University of Iowa e-mail address (@uiowa.edu). Faculty and students should use this account for correspondences. (Operations Manual, III.15.2. Scroll down to k.11.)

**CLAS Final Examination Policies**
Final exams may be offered only during finals week. No exams of any kind are allowed during the last week of classes. Students should not ask their instructor to reschedule a final exam since the College does not permit rescheduling of a final exam once the semester has begun. Questions should be addressed to the Associate Dean for Undergraduate Programs and Curriculum.

**Understanding Sexual Harassment**
Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassment for assistance, definitions, and the full University policy.

**Reacting Safely to Severe Weather** In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit the Public Safety website.*These CLAS policy and procedural statements have been summarized from the web pages of the College of Liberal Arts and Sciences and The University of Iowa Operations Manual.