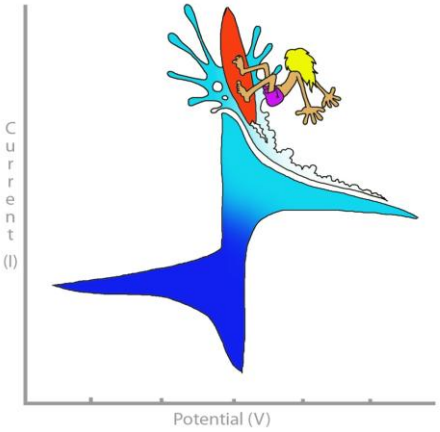
Special Topics in Inorganic Chemistry: Inorganic Spectroelectrochemistry

Chem 721



Instructor: David Vicic, Office: Bilger 321C
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Lecture: TR 7:30 – 8:45 am, Bilger 341C
Office hours: anytime, or by appointment.

Prerequisite: CHEM 422 (or concurrent) or consent

Course Description: This course will provide a contemporary introduction to inorganic electron transfer reactions and the methods used to generate and study transition-metal complexes containing unpaired electrons.

The initial focus of the course will be on the fundamentals of electrochemistry because an understanding of energy data in the form of redox potentials helps assess how difficult it can be to oxidize or reduce a metal complex. Moreover, electrochemistry as a field has become truly interdisciplinary in modern-day science, so a basic knowledge of electrochemical methods will prepare students for a variety of professional endeavors. Electrochemistry is involved in the transformation of materials, plays important roles in biochemical processes, can be used to elucidate formal reaction mechanisms via kinetic analysis, and is especially important in the conversion and storage of energy. Additionally, exciting synthetic transformations are known to proceed from transient odd-electron metal species which can be chemically or electrochemically generated.

The latter part of the course will focus on the use of other spectroscopic techniques in combination with electrochemistry to identify unknown species that are formed as intermediates or as products in a redox reaction. A special emphasis will be placed on electron paramagnetic resonance (EPR) spectroelectrochemistry. The University of Hawaii at Manoa has recently acquired the only EPR spectrometer in the state of Hawaii, and we will learn how this instrument can be used to provide a more complete analysis of electron-transfer processes and complex redox reactions.

Textbooks: *Required:* (1) "Electron Paramagnetic Resonance: A Practitioner's Toolkit" by Marina Brustolon and Elio Giamello. ISBN-13: 978-0470258828; Publisher: John Wiley & Sons.

Recommended: (1) "Electrochemical Methods: Fundamentals and Applications (2nd Edition)" by Allen J. Bard and Larry R. Faulkner. ISBN-13: 978-0471043720; Publisher: John Wiley & Sons. (2) "Inorganic Electrochemistry: Theory, Practice, and Application", by Piero Zanello. ISBN-13: 978-0854046614; Publisher: The Royal Society of Chemistry.

Tentative Schedule

Exam 1: **Electron Paramagnetic Resonance (EPR) Spectroscopy**

- Introduction to EPR spectroscopy
- What can be studied with EPR spectroscopy?
- Analysis of EPR spectra
- Examples of EPR spectra of organometallic complexes containing one or more unpaired electrons
- Advanced techniques

Exam 2: **Electrochemistry**

- Fundamentals of electrode reactions
- Electrodes, solutions, and cells
- Current as a measurement of the rate of a reaction
- Potential as a measurement of the energy of the electrons inside the electrode
- Kinetic aspects of electrode reactions
- Cyclic voltammetry
- The chemical meaning and diagnostic criteria of an electrochemically reversible, irreversible, and quasireversible process
- Chemical reactions coupled to electron transfers
- Consecutive electron transfer processes
- Electrochemical techniques complementary to cyclic voltammetry

Exam 3: **Spectroelectrochemical Techniques**

- Combining electrochemistry and other forms of spectroscopy – surprisingly easy and inexpensive!
- EPR spectroelectrochemistry
- Targeting mixed valence intermediates with spectroelectrochemistry
- Spectroelectrochemistry of metalloporphyrins
- Spectroelectrochemical investigations on carbon-rich organometallic complexes
- Infrared spectroelectrochemistry

Grading:

Exam 1	100 points	(Feb. 10th)
Exam 2	100 points	(Mar 15th)
Exam 3	100 points	(Apr 12th)
Homework	200 points	
Presentation	200 points	
Final (cumulative)	300 points	(May 12th, 7:30 – 9:30 am)
Total	1000 points	

*No late assignments will be accepted. There will be **no** make-up exams offered. Random in-class quizzes may be given in place of homeworks and also to serve as an attendance check.*

Presentations: A PowerPoint presentation (at least 30 minutes) to the class on a current journal paper is required. The paper must have been published in 2008 or later and contain a substantial amount of spectroelectrochemical data. I can help suggest papers, and I must approve all papers before presentation.

Grading Scale: A (100-86%), B (85-76%), C (75-66%), D (65-56%), F (below 56%). If I give a test that is too hard (i.e., the class does poorer than I expect) I *may* curve the scores up to compensate. The exact criteria for when I will do this and the amount of the curving will not be defined here. You will have to trust my judgment.

Attendance: Mandatory

Student Learning Outcomes: Upon completion of this course, students will be able to:

(1) interpret cyclic voltammograms and other electrochemical data
(2) interpret electron paramagnetic resonance spectra
(3) assign redox transformations using spectral evidence

Additional information:

- Academic honesty policies can be found in the UH Student Conduct Code: http://www.hawaii.edu/student/conduct/
- Much of the materials used for class (as well as answers to quizzes, homework, etc.) will be placed on Laulima. Please log on to https://laulima.hawaii.edu/portal on a regular basis to check.

Important dates:

Mar 21 - 25	Spring Break
May 4	Last day of class
May 9-13	Finals period

Accommodations: This class welcomes all students. If you feel that you need accommodations for a disability, please contact me privately to discuss your needs. Please also contact the KOKUA office (956-7511) to coordinate reasonable accommodations for students with documented disabilities.