

GEORGE MASON UNIVERSITY
Electroanalytical Chemistry
CHEM 625
Fall 2008

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The objective of this course is to introduce the basic principles of electrochemical science for analytical purpose. It includes potentiometric, and voltammetric techniques and their applications. Since the scope of applications is enormous and covers almost all branches of science, the course will only cover selected and important applications of electrochemical techniques as an analytical tool i.e., how to measure and study low level concentrations of redox species in solution. As a prerequisite to this course, you should have a background in calculus, quantitative analysis, and physical chemistry. The course also has a three class-period of laboratory experiments. During this lab period, you will perform a series of basic experiments with modern electrochemical systems. The laboratory work has been designed to strengthen the theoretical background in electrochemistry. The course will be graded based on assigned homework problems, laboratory reports, and examinations.

Text: Electrochemical Methods: Fundamentals and Applications By Allen. J. Bard and Larry. R. Faulkner, 2nd Edition.

LECTURE TOPICS

1. Introduction and review of basic electrochemistry: Electrochemical reactions and cells
2. Overview of electrode processes: Faradaic and Nonfaradaic processes, Nature of electrode solution interface (Chapter 13- Double layer structure), Semiempirical treatment of mass transfer: Chapter 1
3. Thermodynamics of cell: Measurement of potential difference, liquid junction, ion selective electrodes and sensors: Chapter 2
4. Kinetics of Electrode Processes: Butler-Volmer model, reversible and irreversible electron transfer reactions: Chapter 3
5. Mass transfer during electrolysis: Ficks laws of diffusion and boundary value problems: Chapter 4
6. Controlled Potential Techniques. Chronoamperometry, Chronocoulometry, Cyclic voltammetry, Pulse Polarography and voltammetric techniques, Stripping voltammetry, and Convolution voltammetry: Chapters 5, 6, and 7.
7. Controlled current technique. Chronopotentiometry, Galvanostatic and Coulostatic techniques: Chapter 8
8. Bulk electrolysis methods: Coulometry, stripping voltammetry, and thin layer electrochemistry: Chapter 11
9. Review of electrochemical sensors: Amperometric, Galvanic, Potentiometric, and Conductimetric, and Ion-Channels

10. Scanning probe techniques (Chapter 16) and electrochemistry in organized media

LABORATORY EXPERIMENTS

Laboratory instruction manual will be distributed in class.

1. Measurement of solution resistance, double layer capacity of the electrode and time constant of the potentiostat
2. Double potential step chronoamperometry and chronocoulometry of a redox couple.
3. Chronopotentiometry of $[\text{Fe}(\text{CN})_6]^{3-}/[\text{Fe}(\text{CN})_6]^{4-}$ redox Couple.
4. Cyclic voltammetry of a redox couple with micro and ultramicroelectrodes.
5. Pulse Voltammetry: Effect of pulse properties and current sampling time
6. Discover What's Going On: Open circuit techniques
7. Experiments with electrochemical gas sensors

HOMEWORK PROBLEMS

To be announced, distributed, and discussed in the class

GRADE DISTRIBUTION

1. Homework assignments: 30%
2. Laboratory reports: 30%
3. Midterm Exam: 10%
4. Final Take Home Examination: 30%

ARTICLES OF INTEREST: IN ANALYTICAL CHEMISTRY A-PAGES

1. Geary, C. D.; Weber, S. G. *Anal. Chem.* 2003, 75, 6560-6565.
2. Olivier T. Guenat et al., *Anal. Chem.* 2000, 72, 1585-1590.
3. Kasianowicz, J. J. et. al., *Nanosopic Porous Sensors*
4. *Electrochemistry, endocrine disruptors, and he environment* February 1, 2002; volume 74; p. 66 A
5. *Charge Transfer Reactions at the Liquid/Liquid Interface* December 1, 2001; volume 73; p. 670 A
6. *Detection in the danger zone* August 1, 2001; volume73; p. 410 A
7. *Extreme electrochemistry* July 1,2001; volume 73 ; p. 355 A
8. *DNA Hybridization and Damage* February 1, 2001; volume 73; p. 75 A
9. *Mixing electrochemistry with microscopy* January 1, 2001; volume 73; p. 39 A
10. *Voltammetric and Amperometric Detection without Added Electrolyte* December 1, 2000; volume 72; p. 754 A
11. *Sol-Gel and Electrochemistry: Research at the Intersection* November 1, 2000; volume 72; p. 702 A
12. *Voltammetry Retrospective* May 1, 2000; volume 72; p. 346 A
13. *Voltammetry—Spanning the Kinetic Timescale* March 1, 2000; volume 72; p. 198 A

