635:440
Electrochemical Materials and Devices
Department of Materials Science and Engineering
#20749 – M+Th from 12:00 to 1:20 in BME 116

Description:

Electrochemical materials and devices are playing an ever-increasing role in our technology driven society. Electrochemical energy storage and conversion devices such as advanced batteries and fuel cells are in massive and rapidly growing demand as the power source for numerous wireless telecommunication devices and portable information technologies, and for the forthcoming electric and hybrid vehicles on the world's transportation scene. The concept of micropower, by which electricity is generated by efficient, pollution-free on-site fuel cells instead of coal-burning power plants, is also gaining considerable momentum. Electrochemical sensors are yet another massive field where countless industrial, environmental and biomedical applications are found. This course will give an introduction to basic electrochemistry, principles of electrochemical devices, electroactive materials used in such devices, and case studies of batteries, fuel cells, and sensors. An emphasis is placed on the integration of electrochemical principles and materials science for innovating in the area of modern electrochemical devices.

Objective:

To give students a solid foundation of basic electrochemistry and principles of electrochemical devices, as well as an introduction to solid state electrochemical materials and case studies on how the integration of scientific principles and advanced materials leads to modern devices. The course is of interest to majors in materials science, chemistry, chemical and biomedical engineering, electrical and mechanical engineering, physics, and other science or engineering fields.

Prerequisites:

While there are no specific pre-requisites, it is expected that students should be familiar with the basics of introductory chemistry, the period table of elements, bonding, and understanding of energetics in chemical reactions.

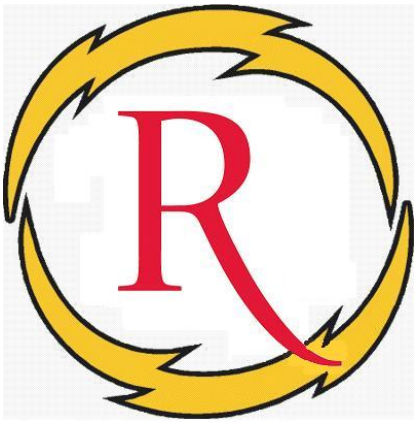
Topical Coverage:

Fundamentals and Experimental Methods

- Thermodynamics of reactions with emphasis on electron transfer and oxidation/reduction processes, leading to key electrochemical equations.
- Connection to period table and understanding effective utilization of specific elements in batteries and electrochemical processes.
- Examination of reactions and defects in the solid state.
- Critical metrics and measurements of electrochemical devices: charge/discharge, power density, energy density, transference number,
- Influence of structure on conduction rates and function.
- Frequency-dependent and rate-dependent behavior.

Device Technology and Applications

- Batteries (direct and rechargeable: Pb-acid, NiCd, Li, etc…)
- Fuel Cells (Polymer, Solid-oxide)
- Electrochemical sensors (oxygen sensors, pH, etc…)
- Electrochromic devices (window tinting)
- Electric and Hybrid Vehicles (EV, PHEV, etc…)
- Power for Medical Implants (pacemakers)
- Energy storage for the “smart grid”.
- Supercapacitors



Course Instructor:

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