

DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING  
KOREA ADVANCED INSTITUTE OF SCIENCE AND TECHNOLOGY

## MS658

# ~~Materials Science Aspects of Rechargeable Batteries~~ **Solid State Electrochemistry for Energy Storage and Conversion**

Fall Term 2013

Limitations in accessible fossil fuels and increases in world population have lead to large increases in the cost of fossil fuels. In addition, worldwide concern about the environmental consequences of fossil fuel combustion has increasingly grown, demanding economic and efficient energy systems. Electrochemical means of converting and storing energy have great promise as alternative energy options for transportation and stationary applications due to their superior efficiencies. In this class, students will learn fundamental concepts and tools of electrochemistry based on materials science and further focus on the understanding of the operation mechanism and the material requirements of various advanced electrochemical devices, including batteries, fuel cells and electrochemical capacitors.

Instructor:

Professor WooChul Jung 정우철 (Rm 2406, W1-1, [wchung@kaist.ac.kr](mailto:wchung@kaist.ac.kr))

Class Hours:

Monday, Wednesday, Friday (Rm 1317, 13:00 – 13:50)

Office Hours:

By appointment

Web site:

<http://seml.kaist.ac.kr>

Grade Calculation:

Participation	50%
Quiz1&2	20%
Final project	30%

References:

Y-M. Chiang, D.P. Birnie and D. Kingery, Physical Ceramics, Wiley, 1996.  
Joachim Maier, Physical Chemistry of Ionic Materials, Wiley, 2004.  
A.J. Bard and L.R. Faulkner, Electrochemical Methods, 2<sup>nd</sup> ed., Wiley, 2001.  
R.A. Huggins, Advanced Batteries, Springer, 2009.  
R. O'Hayre, S.-W. Cha, W. Colella, and F.B. Prinz, Fuel Cell Fundamentals, Wiley 2009.

Week	Topic
1	Introduction to Electrochemical Energy Technologies -The Global Energy Landscape -Overview: Fuel Cells and Batteries
2	Solid State Chemistry Review -Gibbs Free Energy, Phase Equilibrium -Crystallography
3	Bulk Defect Chemistry, <b>No Class (09/18 &amp; 09/20, Thanksgiving)</b> -Point Defects
4	Bulk Defect Chemistry -Kröger-Vink Notation, Brouwer Diagrams
5	From Defects to Conductivity -Purely Ionic Conductors, Mixed Ionic/Electronic Conductors -Atomistics of Charge Transport, Conductivity in Polymers
6	Internal Interfaces, <b>No Class (10/09, Hangeul Day)</b> -Grain Boundaries, Secondary Phases -Space Charge Potential
7	Basics of Electrochemistry, <b>No Class (10/18, Conference)</b> -Chemical and Electrical Driving Forces -Potentials of Electrochemical Cells
8	Electrode Processes, <b>No Class (10/23 &amp; 10/25, Mid-term Period)</b> -Electrochemical Reactions
9	Electrode Processes -Models for Electrode Kinetics -Polarization Behavior
10	Fuel Cell Lectures -Fuel Cell Thermodynamics and Kinetics
11	Fuel Cell Lectures, <b>No Class (11/15, Undergraduate Admission)</b> -PEMFC and SOFC Materials
12	Battery Lectures -Battery Thermodynamics and Kinetics
13	Battery Lectures -Battery Materials
14	Electrochemical Methods -Controlled Potential & Current Techniques -Techniques based on Concepts of Impedance
15	<b>Student Presentation</b>
16	<b>Student Presentation</b>

No Class on the Following Dates:

9/18, 09/20 (Thanksgiving Holiday)  
10/09 (Hangeul Proclamation Day)  
10/18 (Korean Ceramic Society meeting)  
10/23, 10/25 (Mid-term Period)  
11/15 (Undergraduate Admission Process)

Last Day of Class:

12/16 (Last Class)

Make-up Dates:

10/21