ChE-603(2)

Interfacial Electrochemistry of Metals and Semiconduc-tors for Energy Conversion and Storage 2 - Advanced Topics

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Cursus	Sem.	Type
Chemistry and Chemical Engineering		Obl.

Language of teaching	English
Credits	2
Session	
Exam	Written, Multiple
Workload	60h
Hours	**28**
Courses	28
Number of positions	

Frequency

Every year

Remark

Every year

Summary

The course is the continuation of Interfacial Electrochemistry of Metals and Semiconductors for Energy Conversion and Storage 1 â## Fundamentals (CH-G1-603) and is focused, based on the material presented on the latter course, on the description of advanced electrochemical theories and their applica

Content

1) Application of irreversible thermodynamics to describe transport phenomena in electrolytes and to determine the diffusion potential at the contact between two electrolytes.
2) Determination of electrode potentials by potentiometric and voltammetric methods. Reference electrodes in aqueous and non-aqueous solutions.
3) Doping of oxide semiconductors used in photoelectrochemical systems.
4) Construction and interpretation of electrode potential vs. pH (Pourbaix) diagrams
5) Application of electron and hole transport and physical kinetics concepts to processes at the electrode side of the semiconductor-electrolyte interface in conjunction with electrochemical reactions, in the dark and under irradiation.
6) Kinetics of multistep electrode reactions. Detailed description of some reactions of interest to electrochemical energetics including these occurring in water electrolysers and hydrogen-oxygen fuel cells, oxidation of organic compounds, and carbon dioxide reduction. Heterogeneous electrocatalysis.
7) Detailed description of the p-n diode equation. Contemporary research in photoelectrochemical research incorporating illuminated p-n junctions (photoelectrochemical diodes).
8) Definitions of solar-to-chemical energy conversion efficiency in photoelectrochemical systems
9) Work function in electrochemistry and absolute electrode potential.
10) Double layer theories at metal and semiconductor electrodes. Double layer effects in electrode kinetics. Thermodynamics of the semiconductor oxide-electrolyte interface.
11) Electron transfer theories at metal and semiconductor electrodes according to the Marcus-Gerischer model.
12) Surface electrochemistry: electrodeposition at metal electrodes, anodic metal dissolution, kinetics at chemically modified electrodes and their application to batteries and electrochemical supercapacitors, electrochemistry of electronically conducting polymers.
13) Application of electrode kinetic equations to the description of batteries and fuel cells.
14) Enzymatic and microbial biofuel and electrolytic cells, including these including photoelectrodes.
15) Dye-sensitized electrodes for electricity and solar fuel generation, analysis of recent recent research.
Examination: Written examination, homework assignments and one term paper.

Keywords

Electrochemistry, Energy Conversion, Thermodynamics, Kinetics, Photoelectrochemistry

Learning Prerequisites

Recommended courses

Undergraduate-level physical chemistry.
CH-G1-603

Resources

Bibliography

Basic Textbooks
1) Bagotsky, V.S., Fundamentals of Electrochemistry, 2nd Ed., Wiley, 2005.
2) Memming, R., Semiconductor Electrochemistry, 2nd Ed., Wiley, 2015.
Supporting references
1) Albery, J., Electrode kinetics, Clarendon Press, 1975.
2) Bagotsky, V.S., Fuel Cells, 2nd Ed., Wiley, 2012.
3) Bagotsky, V.S., Skundin, A., and Volfkovich, Y.M., Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors, Wiley, 2015.
4) Bockris, J. O'M., Reddy, A.K.N., Modern Electrochemistry, An Introduction to an Interdisciplinary Area, Volumes 1 and 2, Plenum, 1970.
5) Bockris, J. O'M., Reddy, A.K.N., Modern Electrochemistry, Second Edition, Volume 1, Ionics, Kluwer/Plenum, 1998; Volume 2, with Gamboa-Aldeco, M., Fundamentals of Electrodics, Kluwer, 2000; Volume 3, Electrodics in Chemistry, Engineering, Biology, and Environmental Science, Kluwer, 2002.
6) Bard, A.J., Inzelt, G., Scholz, F., Electrochemistry Dictionary, 2nd Ed., Springer, 2012.
7) Grimes, C.A., Varghese, O.K., and Ranjan, S., Light,Water, Hydrogen: The Solar Generation of Hydrogen by Photoelectrolysis, Springer, 2008.
8) Koryta, J. Dvorak, J. and L. Kavan, L., Principles of Electrochemistry, Second Edition, Wiley, 1993
9) Lefrou, C., Fabry, P., Poignet, J.-C., Electrochemistry, the Basics, with Examples, Springer, 2012.
10) Morrison, S.R., Electrochemistry at Semiconductor and Oxidized Metal Electrodes, Plenum, 1980.
11) Oldham, K.B., Myland, J.C., Bond, A.M., Electrochemical Science and Technology, Wiley, 2012. Student companion site: http://bcs.wiley.com/he-bcs/Books?action=index&bcsId=7004&itemId=0470710845 (accessed 21-08-2018)
12) Pleskov, Y. V., Gurevich, Y. Y., Semiconductor Photoelectrochemistry, Consultants Bureau, 1986.
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14) Sato, N., Electrochemistry at Metal and Semiconductor Electrodes, Elsevier, 1998.
15) Scott, K., Sustainable and Green Electrochemical Science and Technology, Wiley, 2017.
16) Sharon, M., An Introduction to the Physics and Electrochemistry of Semiconductors, Fundamentals and Applications, Wiley, 2016.

Ressources en bibliothèque

- Fundamentals of electrochemistry / Bagockij
- Semiconductor electrochemistry / Memming

Références suggérées par la bibliothèque

- Electrode kinetics / Albery
- Fuel cells / Bagotsky
- Electrochemical power sources / Bagotsky
- Electrochemical dictionary / Bard
- Light, water, hydrogen / Grimes
- Principles of electrochemistry / Koryta
- Electrochemistry / Lefrou
- Electrochemical science and technology / Oldham

- Instrumental methods in electrochemistry / Robinson
- Electrochemistry at semiconductor and oxidized metal electrodes / Morrison
- Semiconductor photoelectrochemistry / Pleskov
- Electrochemistry at metal and semiconductor electrodes / Sato
- Sustainable and green electrochemical science and technology / Scott
- An introduction to the physics and electrochemistry of semiconductors / Sharon
- Modern Electrochemistry 2nd. ed. / Bockris
- Modern electrochemistry : an introduction to an interdisciplinary area / Bockris