

CH-724

Electrochemistry of metals and semiconductors

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Cursus	Sem.	Type
Chemistry and Chemical Engineering		Opt.

Language of teaching	English
Credits	2
Session	
Exam	Written
Workload	60h
Hours	28
Courses	28
Number of positions	30

Frequency

Only this year

Remark

From 1st March until 30th May 2021

Summary

The course presents, with emphasis to fundamental physicochemical principles, the basic principles of electrochemical thermodynamics and physical and chemical kinetics as applied to electrochemical conversion systems: batteries, fuel and biofuel cells, electrolysers, and photoelectrochemical cells.

Content

- 1) Summary of the principles of chemical and electrochemical thermodynamics of relevance to electrochemical energetics.
- 2) Outline of basic concepts of solid-state physics of metals and semiconductors.
- 3) Thermodynamics of the metal-electrolyte and semiconductor-electrolyte interface and of electrochemical cells on the basis of the electrochemical potential concept.
- 4) Transport properties of electricity carriers in ionic and electronic conductors, migration and diffusion.
- 5) Electrochemical kinetics and catalysis at metal and semiconductor electrodes, introduction to complex multi-step electrode reactions, adsorption effects.
- 6) Electrochemical double layer at metal and semiconductor electrodes
- 7) Comparative description of electrochemical systems: primary and secondary batteries, fuel and biofuel (enzymatic and microbial) cells, water electrolysers, electrochemical supercapacitors.
- 8) Comparative description of photoelectrochemical systems based either on direct semiconductor photoexcitation or on dye sensitisation of semiconductors: electrochemical photovoltaic (electricity-producing) cells, photoelectrosynthetic cells (including e.g. photoelectrochemical water splitting and electrochemical carbon dioxide reduction), photocatalytic cells (including photoelectrochemical fuel and biofuel cells).
- 9) Hybrid photovoltaic-electrochemical and photovoltaic-photoelectrochemical systems for solar fuel generation and solar energy storage.
- 10) Application of electrochemical principles to microdispersed photocatalytic systems for energy conversion.

Keywords

Electrochemical cells, photoelectrochemical cells, electrochemical thermodynamics, electrochemical kinetics, overvoltage, solar energy conversion and storage, migration, double layer.

Learning Prerequisites**Important concepts to start the course**

General undergraduate chemistry and physics for scientists and engineers.

Learning Outcomes

By the end of the course, the student must be able to:

- Take into consideration the concept of electrochemical potential
- Apply cell voltage as the sum of the voltages in all interfaces comprising the electrochemical cell.

Assessment methods

2021 : WRITTEN TAKE-HOME FINAL EXAM (REPORT) report

Resources

Bibliography

BASIC TEXTBOOKS

- 1) Koryta J., Dvorak J., Kavan, L., Principles of Electrochemistry, Second Edition, Wiley, 1993.
- 2) Bagotsky, V.S., Fundamentals of Electrochemistry, 2nd Ed., Wiley, 2005.

SUPPORTING REFERENCES

- 1) Bagotsky, V.S., Skundin A., Volkovich Y. M., Electrochemical Power Sources, Batteries, Fuel Cells, and Supercapacitors, Wiley, 2015.
- 2) Girault H., Analytical and Physical Electrochemistry, EPFL Press, 2004.
- 3) Grimes C.A., Varghese O.K., Ranjan S., Light, Water, Hydrogen: The Solar Generation of Hydrogen by Photoelectrolysis, Springer, 2008.
- 4) Lefrou C., Fabry P., Poignet J.-C., Electrochemistry, the Basics, with Examples, Springer 2012.
- 5) Memming, R., Semiconductor Electrochemistry, 2nd Ed., Wiley, 2015.
- 6) Oldham K.B., Myland J.C., Bond A.M., Electrochemical Science and Technology, Wiley, 2012.
- 7) Sharon M., An Introduction to the Physics and Electrochemistry of Semiconductors, Wiley, 2016.

Ressources en bibliothèque

- [Principles of electrochemistry / Koryta](#)
- [Fundamentals of electrochemistry / Bagotsky](#)
- [Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors / Bagotsky](#)
- [Analytical and Physical Electrochemistry / Girault](#)
- [Light, Water, Hydrogen : The Solar Generation of Hydrogen by Water Photoelectrolysis / Grimes](#)
- [Electrochemistry : the basics, with examples / Lefrou](#)
- [Semiconductor Electrochemistry / Memming](#)
- [Electrochemical science and technology : fundamentals and applications / Oldham](#)
- [An introduction to the physics and electrochemistry of semiconductors : fundamentals and applications / Sharon](#)