Universidad Zaragoza

Academic Year/course: 2020/21

60645 - Electrochemistry and Photochemistry for Industry

Syllabus Information

Academic Year: 2020/21
Subject: 60645 - Electrochemistry and Photochemistry for Industry
Faculty / School: 100 - Facultad de Ciencias
Degree: 540 - Master's in Industrial Chemistry
ECTS: 6.0
Year: 1
Semester: Second semester
Subject Type: Compulsory
Module: ---

1. General information

1.1. Aims of the course

1.2. Context and importance of this course in the degree

1.3. Recommendations to take this course

2. Learning goals

2.1. Competences

2.2. Learning goals

2.3. Importance of learning goals

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process designed for this course combines theoretical concepts with assessment activities and the solving of practical cases close to reality. All these activities will be combined in a strategic way with the student's autonomous work to achieve the best academic output.

In particular, the following activities will be carried out: theory sessions, problem sets and case study, laboratory sessions, assessment tasks, study and reports.

- The theory sessions will be expositive, and in them the fundamental aspects of the course will be developed through the use of the necessary audiovisual/bibliographic media.
- In the problem sets and case study sessions, the student's active participation will be encouraged and valued.
- During the laboratory sessions, special attention will be paid to the correct management of the instruments, the techniques for obtaining experimental data and their validation and subsequent use in the calculation of magnitudes of interest. Unsolved problems and lab sessions will be carried out in small groups for an individualized assistance of the student.

4.2. Learning tasks

The course includes 6.0 ECTS organized according to:

- **Theory Sessions (1.4 ECTS): 36 h.** See the course syllabus
- **Problem Sets and Case Study (0.5 ECTS): 12 h.** Individual solving of advanced electrochemical problems related to electrosynthesis, electrodeposits, corrosion, electrochemical energy converters, reactions and photochemical processes and environmental photochemistry.
- **Laboratory Sessions (0.3 ECTS): 8 h.** Lab sessions show the experimental techniques of working with electrochemical and photochemical reactors.
- **Assessment Tasks (0.2 ECTS): 4 h.** Classroom presentation of assignments and reports.
- **Study and Reports (3.6 ECTS): 90 h.** Autonomous work of the student to carry out the assignments, problem sets, preparation of lab sessions and reports.

4.3. Syllabus

The course will address the following topics:

Topic 1. **Fundamentals of the Electrochemical Synthesis.**

Basic concepts in electrochemical synthesis. Thermodynamic aspects. The electrical double layer. The kinetics of the electrode processes. Transport phenomena. Electrochemical adsorption. Interpreting the components of the cell potential.

Topic 2. **Electrochemical Reactors**. **Components and Operation.**

Basic components in an electrochemical reactor. Solvent selection. The supporting electrolyte. Types of electrodes and the selection criteria. Main materials for anodes and cathodes. Recent developments on electrode materials. Mass transport in the electrochemical reactors. Current and potential distributions. Geometry of reactors. Electric connections. Hydraulic distribution. Heat removal. Types of reactors and selection criteria. Scale-up.

Topic 3. **Traditional and Modern Industrial Applications of the Electrochemical Synthesis**.

The chlor-alkali industry. Fluorine production. Hall-Heroult process of aluminium. Sodium chlorate manufacturing. Production of adiponitrile, a key ingredient for nylon 6,6. Anisaldehyde production (perfume industry). Production of L-cysteine. Maltol production. Electrosynthesis in the pharmaceutical industry.

Topic 4. **Electrochemistry and Environment.**

Electrochemical decontamination. Corrosion: Electrochemical and no electrochemical methods for the corrosion rate measurement. The **c**orrosion prevention. Practical applications in industry.

Topic 5. **Electroplating and Other Related Electrochemical Applications.**

General Aspects of electrodeposition. Parameters affecting the process. Additives. Industrial electroplating. Other electrochemical applications: electroforming, electrowinning and electrorefining of metals; electromachining and electropolishing.

Topic 6. **Electrochemical Energy Conversion and Storage**.

Types of electrochemical converters. Characteristics of commonly used rechargeable batteries. New developments in fuel cell technology.

Topic 7. **Fundamentals of Industrial Photochemistry**.

Photochemical activation of molecules and atoms. Primary and secondary photochemical processes. Mechanisms of deactivation. Quantum yield. The rate of the photochemical reactions. Effect of solvent. Sensitization. Experimental techniques. Photochemical synthesis. Photochemical reactors. Photochemistry in industrial synthesis.

Topic 8. **Other Applications and Effects of Light**. **Photochemistry and Environment.**

Photoinitiators in the polymerization processes. Photochemical depolymerisation of plastics. Sunscreen and sun protection. Photochromism. Environmental photochemistry. Photochemical origin of some chemicals in the troposphere. Kinetics and mechanism of the main tropospheric reactions. Estimating the rate constants and half-lives for the reactions of organic molecules with HO· radicals in the troposphere. Photochemical processes for water treatment.

4.4. Course planning and calendar

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the "Facultad de Ciencias" website https://ciencias.unizar.es/node/7073

4.5. Bibliography and recommended resources

- Bockris, John O'M.. Electroquímica moderna / John O'M. Bockris and Amulya K. N. Reddy ; versión española por José Beltrán Barcelona [etc] : Reverté, D.L.1978-1980
- Bockris, John O. Modern Electrochemistry. 2A Fundamentals of Electrodics. Springer. 2000
- Hamann, Carl H.. Electrochemistry / Carl H. Hamann, Andrew Hamnett and Wolf Vielstich . - 2nd completely rev. and updated ed. Weinheim : Wiley-VCH, cop. 2007
- Wayne, Carol E.. Photochemistry / Carol E. Wayne and Richard P. Wayne . - Repr. with corr. Oxford [etc.]: Oxford University Press, 2002
- Suppan, Paul. Chemistry and light / Paul Suppan Cambridge : Royal Society of Chemistry, cop. 1994

- Bockris, John O'M.. Modern electrochemistry. Vol. 2B, Electrodics in chemistry, engineering, biology and environmental science / John O'M. Bockris, Amulya K.N. Reddy . - 2nd ed. New York [etc.] : Kluwer Academics, 2000
- Ochoa Gómez, José Ramón. Electrosíntesis y electrodiálisis : fundamentos, aplicaciones tecnológicas y tendencias / José Ramón Ochoa Gómez Madrid [etc.] : McGraw-Hill, D.L.1996
- Coeuret, F.. Introducción a la ingeniería electroquímica / F. Coeuret ; edición coordinada por J. Costa López Barcelona [etc.] : Reverté, D.L. 1992
- Corrosion mechanisms in theory and practice / edited by Philippe Marcus . - 2nd ed., rev. and expanded New York [etc.] : Marcel Dekker, cop. 2002
- Kagan, J.. Organic photochemistry: Principles and Applications . Academic Press. 1993
- Albini, Angelo. Photochemistry. v.41 Royal Society of Chemistry. 2013
- Montalti, M.. Handbook of Photochemistry. 3ª CRC Press. 2013