

CH H 563: ADVANCED ELECTROCHEMISTRY

Course Outcome

- It is an advanced level course on electrochemical processes and their applications in chemical industries.
- This course content trains students on alternate methods of synthesis using electrochemical concepts.
- The course enables them to learn the functioning of electrochemical energy systems such as batteries and fuel cells.

UNIT-I

[12 hours]

Electrocatalysis: Introduction. Electrocatalysis in reactions involving adsorbed species, concept and process of electrogrowth on electrodes. Deposition to crystallization, mechanism of electrogrowth. Special features of electrocatalysis. Hydrogen evolution and reactions. Electronation of oxygen and their mechanisms.

Photo-electrocatalysis: History of photocatalysis, Principles and Developments in photo-electrochemistry. Semiconductor-electrolyte solution interface. Effect of light at semiconductor interface. Capacity of space charge - Mott-Schottky plot. Photo cells-PEC cells and Photogalvanic cells.

Analytical Applications of Electrochemistry: Principles and Applications of Polarography, Cyclic voltammetry, Amperometry.

UNIT-II

[12 hours]

Electrode Processes: Charge transfer across the interface and its implications. Basic electrodic reactions: Butler - Volmer equation. Current potential laws at charged interface. Quantum aspects of charge transfer reactions. Concepts of over voltage, Theory of hydrogen and oxygen overvoltage. Mechanism of cathodic and anodic reactions, Dependence of current density on overvoltage: Tafel equation.

The Electrified Interface: Electrification of interfaces, experimental techniques used in studying interface (Low energy electron diffraction, X-ray photoelectron spectroscopy). The potential difference across Electrified interface. The accumulation and depletion of substances at an interface. Thermodynamics of an electrified interface. Brief introduction to the structure of electrified interfaces (models).

UNIT-III

[12 hours]

Electrochemical Energy System: Electricity Storage-Importance, storage density, Fundamentals and classification of batteries, Primary battery (Laclanche-dry cell and Alkaline cell). Secondary battery (acid and alkaline). Reserve batteries. Lithium batteries - (primary and secondary and lithium based conducting polymer battery). Fuel cells – introduction, classification, H_2 - O_2 and bio-cells.

Sensors: Biosensors: Introduction electrochemical bio-sensors- characteristics, use as a transducer, types.

Ion-Sensors: Ion-selective electrode: Introduction, Types. Analytical and biological applications of sensors.

Electrosynthesis: Electro-organic synthesis (Kolbes synthesis, oxidation and reduction of hydrocarbons, reduction of nitro-compounds); Electro inorganic synthesis of fluorine and ozone. Synthesis of metal salts via anodic dissolution.

UNIT-IV

[12 hours]

Metallurgical Processing: Electroplating-fundamentals, mechanism of electrodeposition of metals, application of electroplating. Brief account of Electroless plating, Conversion coatings, Electrophoretic painting.

Metals and materials processing: Theory and applications of Electroforming and Electrochemical etching. Production of metals by electro winning and electrorefining. Applications of electrochemistry in fixing of CO₂, treatment of waste, Metal ion removal and metal recovery. Treatment of liquors containing dissolved chromium.

References

1. Modern Electrochemistry, Vol.1, 2A & 2B, 2nd edn., J. O. M. Bockris and A. K. N. Reddy, Plenum, New York (1998).
2. Chemical and Electrochemical Energy Systems, B. Narayan and R. Viswanathan, Univ. Press, Hyderabad (1998).
3. Fundamentals of Electrochemistry, 2nd edn., L. R. Fulkner and A. J. Bard, Wiley India, (2006).
4. Ions in solution: Basic principles of chemical interactions, J. Burgeess, Chichester: Horwood Publisher (1999).
5. Electrochemistry-Principles, Methods and Applications, A. M. O. Brett and C. M. A. Brett, Oxford Science, (1993).
6. Industrial Electrochemistry, 2nd edn., D. Pletcher & F. C. Walsh, Chapman & Hall (1990).
7. Biosensors: theory and Applications, D. G. Burek, Technomic Publishing Company, (1993).
8. Principles and Applications of Electrochemistry, 4th edn., D. R. Crow, CRC Press, (1994).