

Electrochemistry for materials technology

Chapter 1 Introduction

Electrochemical reactions

Chemical reactions which take place at the interface of an electrode, usually a solid metal or a semiconductor, and an ionic conductor, the electrolyte.

These reactions involve electric charges moving between the electrodes and the electrolyte.

Electrochemistry deals with the interaction between electrical energy and chemical change.

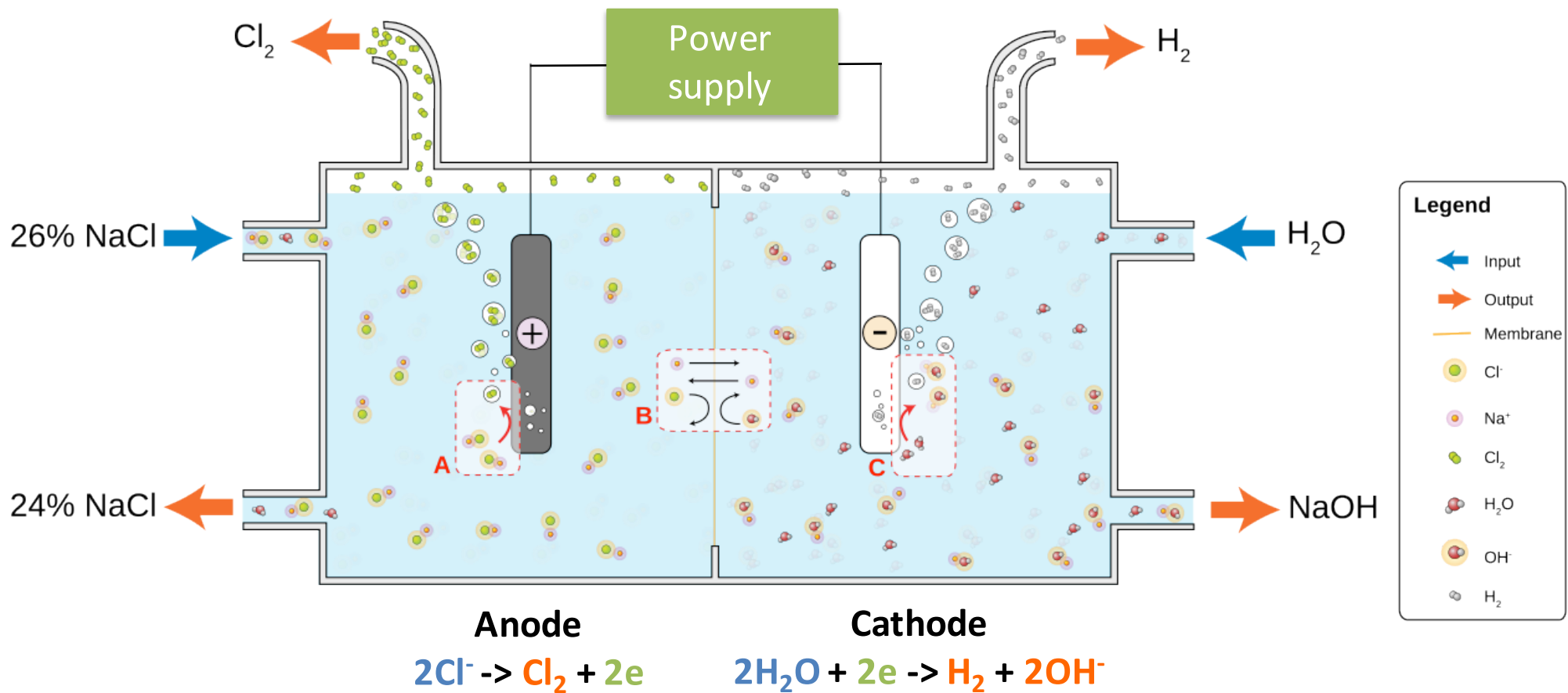
Some dates

- 1791: L. Galvani linked electricity to chemical reactions (bioelectricity).
- 1800: A. Volta discovered the first battery.
- 1800: Discovery of water electrolysis as method to produce hydrogen and oxygen.
- 1805: Electroplating as manufacturing technique
- 1832: Faraday's law formulated.
- 1839: First fuel cell by W. Grove.
- 1868: First patent related to the zinc-carbon cell, i.e. the first widely used battery.
- 1886: Héroult-Hall electrolysis of molten alumina for aluminium production.
- 1889: Nernt's equation for the free energy change in electrochemical reactions.
- 1902: Foundation of the Electrochemical Society in the USA.
- 1905: Tafel's Equation describing electrochemical kinetics

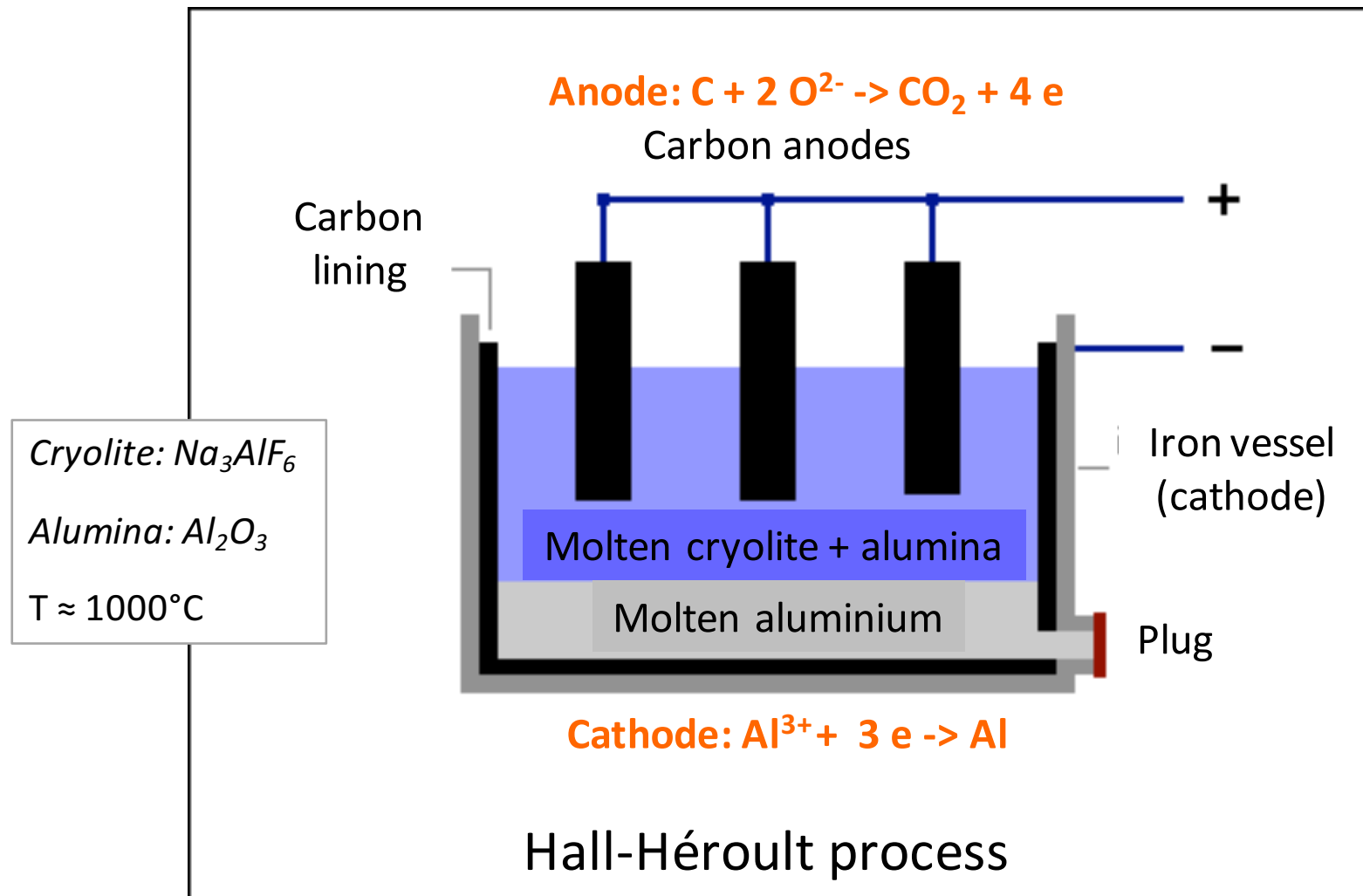
Engineering use of electrochemistry

- **Electrosynthesis**
 - Production of Al, Cl₂, H₂, NaOH, ...
- **Surface treatments**
 - Coatings, anodic films, polishing, electroforming
- **Energy storage and conversion**
 - Batteries, fuel cells, water hydrolysis
- **Corrosion**
 - Mechanisms, protection
- **Analysis and measurement**
 - Sensors for pH, glucose, pollutants
- ...

Electrosynthesis of Cl₂, H₂ and NaOH by electrolysis of NaCl solutions and water



Aluminium production through the electrolysis of aluminium molten salt



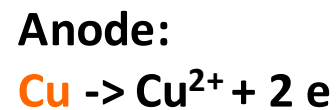
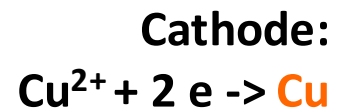
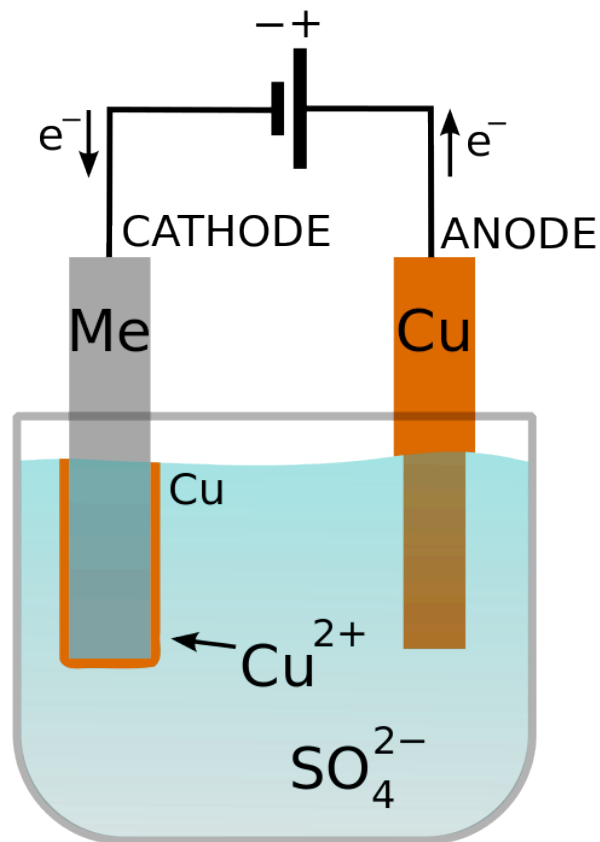
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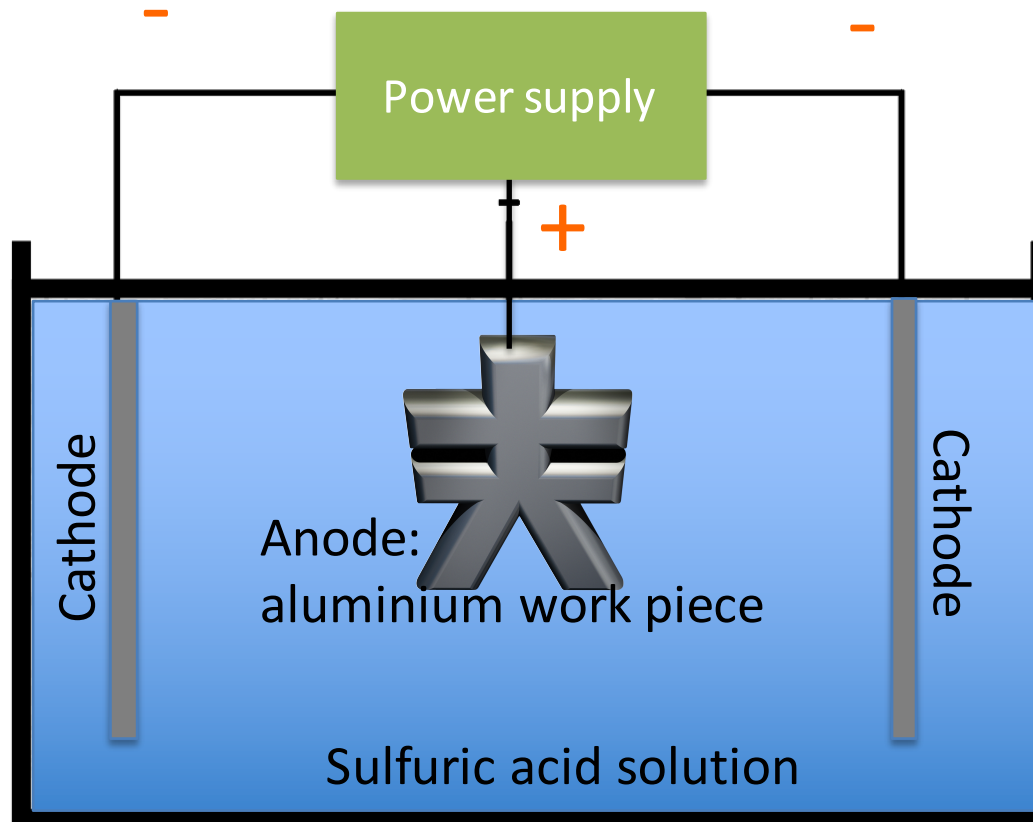
Surface treatments by metal electrodeposition

Principle of electrodeposition

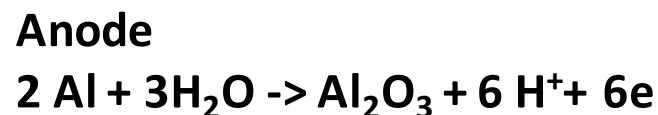
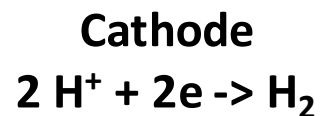
Examples of electrodeposition



Surface treatments by metal anodizing (formation of a metal oxide surface film)



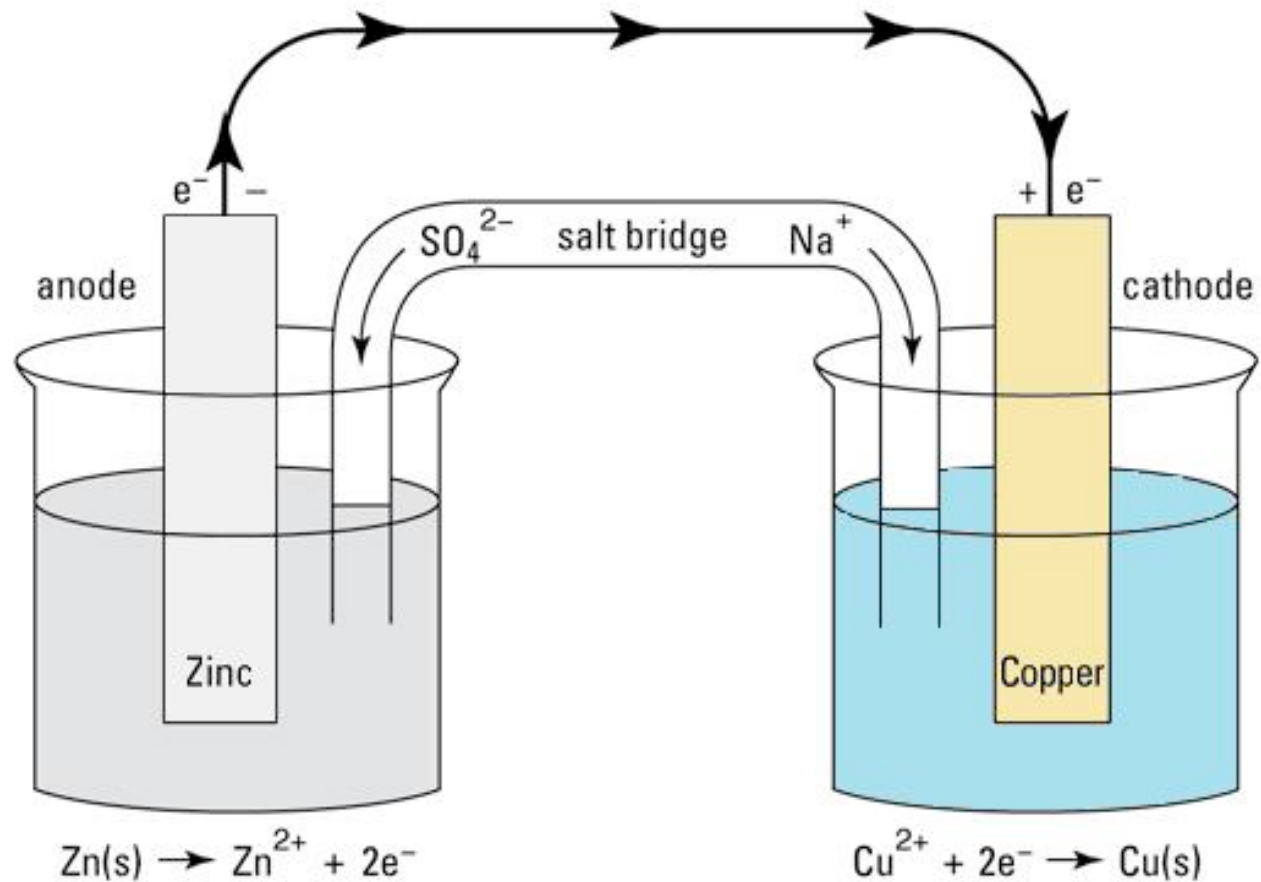
*Car fitting component:
color anodized aluminum*



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Chemical to electrical energy conversion: the Daniell cell

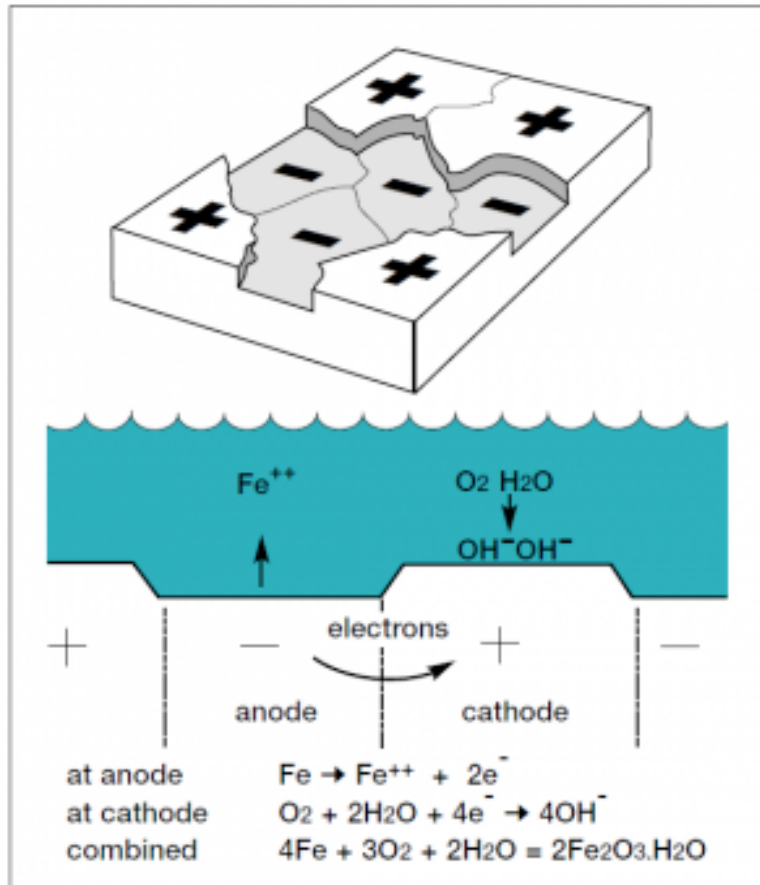


Engineering use of electrochemistry

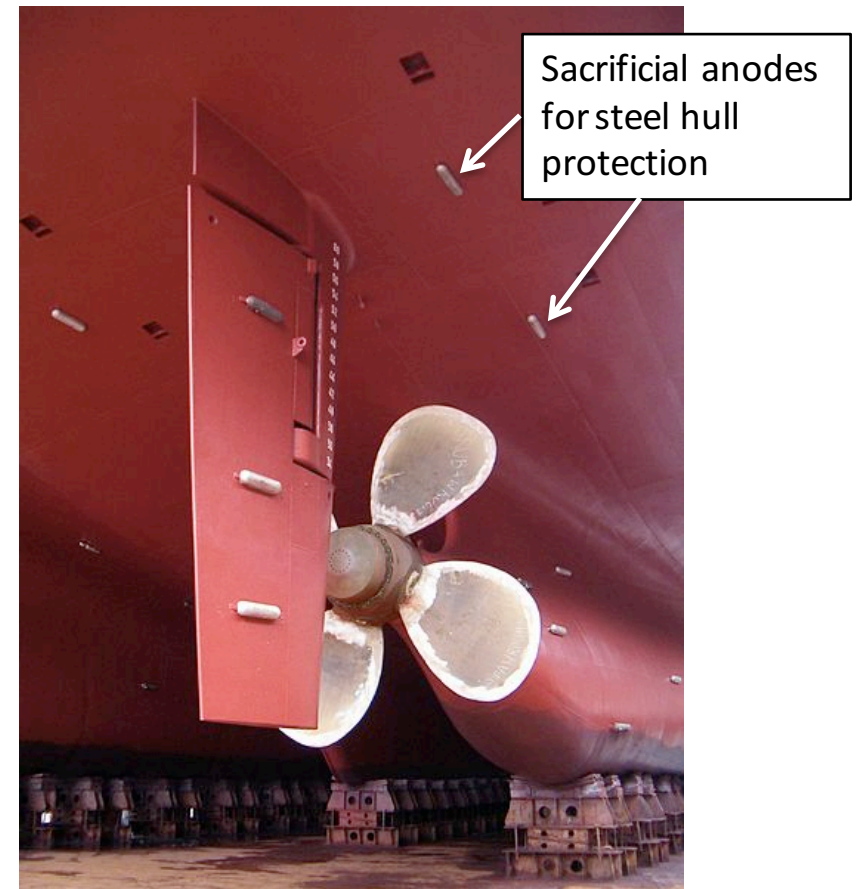
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Corrosion

Corrosion mechanisms



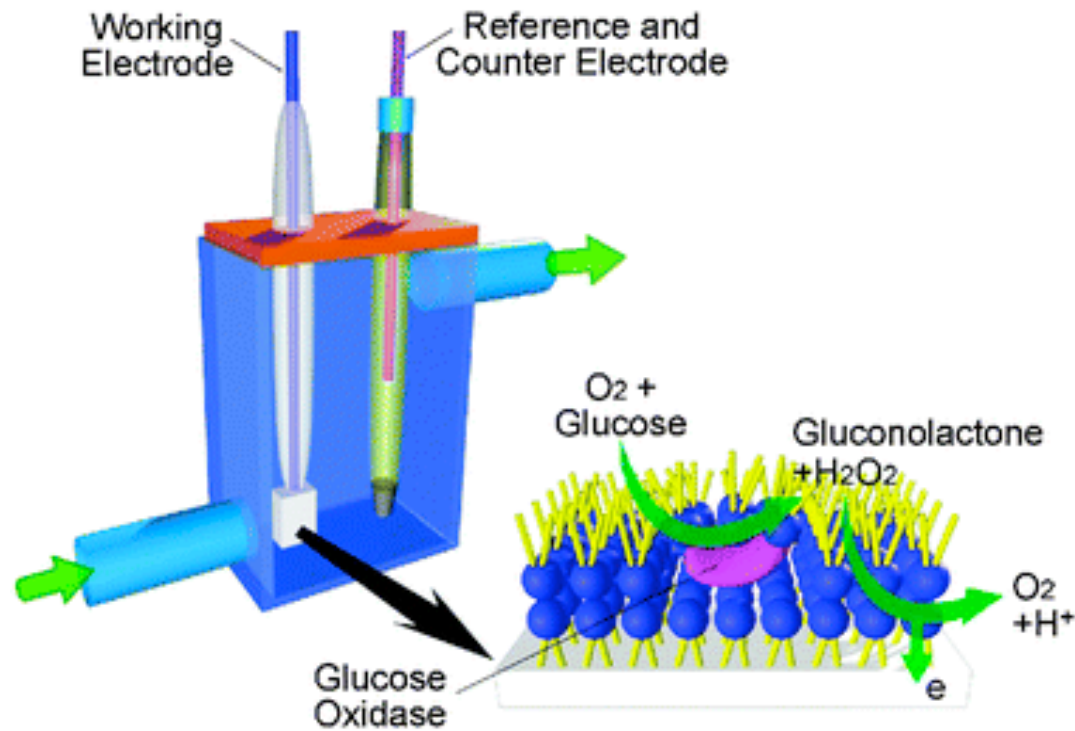
Corrosion protection



Engineering use of electrochemistry

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Glucose sensor based on electrochemical oxidation of hydrogen peroxide



Follow up of the course

- Electrosynthesis (ChE407)
- **Surface treatments**
- **Energy storage and conversion**
- Analysis and measurement (ChE407)
- Environment (ChE407)
- Corrosion (MX Bachelor)

Follow up of the course

- Introduction
- Basics of electrochemistry
 - Electrode reactions and potential, kinetics, experimental methods.
- Electrodeposition and micro-fabrication
 - Coatings, surface patterning, MEMS, nanowires.
- Electrochemistry for energy generation and conversion
 - Batteries, fuel cells, electrolysis, electrochemical synthesis; electric vehicles.