MAPR2140 Supplements in inorganic chemistry

[30h+30h exercises] 5 credits

This course is taught in the 1st semester

Teacher(s): Joris Proost
Language: French
Level: Second cycle

Aims

The objective of this course is two-fold : in the first part, the principles of chemical equilibrium and chemical rate theory will be extended towards electrochemical equilibrium and electrochemical kinetics. The aim of the second part is to apply both the chemical and the electrochemical thermodynamic and kinetic principles towards the description of the processing and the chemical stability of inorganic materials.

Main themes

The first part of the course provides an introduction to electrochemistry, based on previously developed concepts in chemical thermodynamics. The course starts with a description of aqueous, ionic solutions. Next, quantitative expressions are derived that establish the conditions of electrochemical equilibrium for redox reactions occurring at electrode surfaces. Finally, it is explained how, based on the concept of overpotential, classical rate theory can be applied to describe the kinetics of charge transfer at electrodes. Some typical current-potential regimes are discussed, as well as electrochemical characterisation methods and relevant technological applications.
In the second part, both the chemical and the electrochemical thermodynamic and kinetic principles will be applied to the processing and the chemical stability of inorganic materials. Most materials in use by mankind are indeed unstable relative to their environment. It is shown that, for understanding and describing this chemical (in)stability, the same thermodynamic and kinetic principles can be used as the ones governing their extraction (corrosion is merely metal extraction in reverse). Specific attention will be given in this part to the construction and interpretation of relevant engineering diagrams (phase stability, predominance and transformation diagrams).

Content and teaching methods

Part 1 : Introduction to electrochemistry
description of ionic solutions and ion-solvent interactions (Debye-Hückel)
structure of electrified interfaces (double layer, x-potential)
electrochemical free energy change, electrochemical equilibrium (Nernst), reversible half-reactions, electrochemical cells and redox series
overpotentials and electrode kinetics (Butler-Volmer)
characteristic current-potential curves and electrochemical measurements
some electrode reactions and electrochemical systems of technological interest (electrocatalysis, electrodeposition, fuel cells, batteries)
Part 2 : Introduction to the processing and chemical stability of inorganic materials
Ellingham, Kellogg and Chaudron diagrams for predicting high temperature reactivity of inorganic materials in gaseous environments
Pourbaix diagrams for predicting low temperature reactivity of inorganic materials in aqueous solutions
chemical stability of processed metals (environmental behaviour, phase transformations, TTT diagrams)
chemical principles of ceramic processing (phase diagrams, sintering diagrams, LaMer diagrams, colloid stability maps)
Méthodes :
ex-cathedra courses, homework problem sets, exercises

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

MAPR 2310 : Thermodynamics of phase equilibria

Other credits in programs

INCH21	Première année du programme conduisant au grade d'ingénieur civil chimiste	(5 credits)	Mandatory
INCH22	Deuxième année du programme conduisant au grade d'ingénieur civil chimiste	(5 credits)	Mandatory