BRNA2103 Chemistry of solids

[37.5h+0h exercises] 3 credits

This course is taught in the 2nd semester

Teacher(s): Eric Gaigneaux
Language: French
Level: Second cycle

Aims

For the BIR students, this course constitutes the first contact with reactivity of solids. It aims at providing basic elements in the field, mainly tackling inorganic solids. The global objective of the course is to encourage the student, facing a complex phenomenon involving a physical and/or chemical transformation of a solid, to develop reflexes allowing him
- to decompose the phenomenon to find the origin of the transformation and to understand its mechanism
- to determine the parameters influencing the transformation speed rate and the resulting product
- to set up a strategy allowing to master the phenomenon and to force it in a specific direction. The course envisages, as much as possible, the applications and fallouts of the studied concepts in the frame of industrial processes connected with the materials science: conception of new materials, glasses and ceramics, corrosion, # One more specific objective is to provide elements allowing to tackle the field of heterogeneous catalysis in a more specialized course.

Main themes

PARTIM A provides the basis of the chemistry of solids. A first part tackles the general properties of the solids, their classification and energy-related aspects. A second part, important, deals with the defaults in solids, insisting on the fact that the reactivity of the solids is often linked to the types and density of the defaults they contain. Discrimination is made between atomic defaults and dislocations. As far as the first ones are concerned, the course deals with the thermodynamic aspects determining their concentration and their formation in ionic crystals, then in non-stoichiometric solids. Various types of dislocations are discriminated on the basis of the Burger vector.
PARTIM B specifically deals with diffusion-limited processes in solids, in an attempt to decompose them into elementary phenomena: germination, epitaxy and diffusion. Two important sections cover sintering phenomena and tarnishing reactions. In both cases, the various kinetic laws are demonstrated underlying their respective field of application. Complex and concrete examples are given (sintering combined to a chemical phenomenon, spinel formation and double decomposition reactions). The complexity of the diffusion phenomena in chemistry is eventually demonstrated in tackling the coupling phenomena with the example of the activated sintering.

Content and teaching methods

PARTIM A
- General properties of solids and classification of crystalline solids
- Crystal solids theoretical elements: energy of the crystal network, Born-Haber cycle and bands theory
- Defaults in solids: insulating materials, conductors and semi-conductors, atomic defaults, dislocations (types, Burger vector, consequences, stacking defaults).

PARTIM B
- Definition of a diffusion limited process
- Fundamental phenomena: germination, epitaxy, diffusion
- Sintering: physical aspects, kinetics of the first stages and mechanisms, global kinetics and deviances towards ideality, sintering combined to a chemical phenomenon
- Tarnishing reactions: definition, Pilling-Bedworth law, electrical aspects, kinetics of the first stages and mechanisms, examples (S1 + S2 à S3 reactions, double decomposition reactions S1 + S2 à S3 + S4)
- Complex phenomena and coupling: activated sintering, precipitation of a solid into a solid, spinodal decomposition.

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

...)

Precursory courses General chemistry, physiques, mathematics, physical chemistry I
Evaluation Written or oral exam depending on the number of participants
Support Notes given by the professor + chapters of reference books

Other credits in programs

BIR22/3C	Deuxième année du programme conduisant au grade de bio-ingénieur : Chimie et bioindustries (Nanobiotechnologies, matériaux et catalyse)	(3 credits)	Mandatory
CHIM22	Deuxième licence en sciences chimiques	(3 credits)	