UCL Université catholique de Louvain

LBRNA2103

2014-2015

Chemistry of solids

4.0 credits	42.0 h	1q

Teacher(s) :	Gaigneaux Eric ;
Language :	Français
Place of the course	Louvain-la-Neuve
Inline resources:	Icampus
Prerequisites :	General chemistry, mathematics, and general physics as thought in the BIR1BA baccalaureate program ' additional module in chemistry, or equivalents.
Main themes :	The first part (A) of the course gives the basics of the inorganic solids chemistry : general properties, classification and energetic considerations specific to each category of solids, defects (electronic, punctual/atomic, stoichiometric and non-stoichimetric, and multidimensional ones) and the related reactivity, in particular chemical reactivity. Are in addition addressed the thermodynamic aspects dictating concentration and formation of defects. The second part (B) of the course addresses the processes limited by the diffusion in inorganic solids. First a description of elementary phenomena is made: nucleation, epitaxy and diffusion (s.s.); then are addressed sintering phenomena, and tarnishing reactions. In both cases, the different possible kinetic laws are demonstrated. In the end, complex but concrete cases as sintering associated to a chemical event, formation of spinels, double-decomposition reactions, coupled phenomena (as active sintering) are also addressed. The course replaces the addressed concepts in the context of industrial processes concerned by inorganic materials : formulation of new materials, glasses and ceramics, corrosion, and heterogeneous catalysis.
Aims :	a. Contribution de l'activité au référentiel AA (AA du programme) 1.2 2.1 4.4 b. Formulation spécifique pour cette activité des AA du programme At the end of this activity, the student is able, when in front of a complex phenomenon involving a physical and/or chemical transformation of an inorganic solid, to : - break up the mechanism of the phenomenon in order to identify the origin of the transformation and, - determine which are the parameters influencing the rate of the transformation and the nature of its final product - establish a strategy allowing to master and direct the phenomenon. More specifically, at the end of the activity, the student is able to : - categorize and discriminate the different defects in a solid; - predict the physico-chemical properties (hardness, density, mechanical resistance, conductivity, tendency to corrosion, etc) of an inorganic solid on the basis of its structure and/or conditions under which it is submitted, - write the reactions proceeding at the interfaces of solids in the course of a chemical transformation, and - deduce the parameters dictating the progress of the reaction fronts, and - propose the main elements of the corresponding kinetics ; - identify the parameters dictating the tendency of an inorganic solid to sinter or tarnish, and - propose a strategy to adjust these parameters in order to control the rate of the phenomenon. *The contribution of this Teaching Unit to the development and command of the skills and learning outcomes of the programme(s) can be accessed at the end of this sheet, in the section entitled "Programmes/courses offering this Teaching Unit".*
Evaluation methods :	Written examination systematically addressing the main LO of the course.
Teaching methods :	Lectures using notes available on the iCampus platform at the beginning of the course. Constant interaction with the students via questions-answers allowing the students to assimilate the content during the lessons.
Content :	Part A - General properties of solids and classification - Theory of crystalline solids : energy of crytals (for ionic solids), Madelung's approach, Born-Haber cycle, and band theory (for covalent and metallic solids) - Defects in solids :

	§ electronic defects and links with insulating, conducting and semi-conducting (n or p) properties of solids, link between defects concentration, energetic cost of defects formation, and electronic conductivity § atomic (puncual) defects: stoichiometric (Schottky, Frenkel, anti-Schottky) and non stoichimetric, link between defects concentration, energetic cost of defects formation, and ionic conductivity, link with the diffusion and tendency to corrosion. § dislocations : corner and screw types, Burger's vector, link between the diffusion related to dislocations et some catalytic properties § other defects bi- et tridimensional. Part B - Definition of diffusion limited processes - Basic phenomena: germination, epitaxy, diffusion - Sintering : physical aspects, first stages kinetics and mechanisms (plastic deformation, sublimation-deposition, dissolution-deposition, diffusion in the bulk), global kinetics and deviations to reality, sintering associated to a chemical event - Tarnishin reactions : definition, Pilling-Bedworth's law, first stages kinetics and different mechanisms (ultrathin layers ' logarithmic law, thin layer ' Hauffe's law, thick layers ' Wagner's law, thickness non-depending cases), examples (reactions S1 + S2 àS3, double-decomposition reactions S1 + S2 àS3 + S4) Complex phenomena and coupling : calcintering, precipitation of a solid in a solid and spinodal decomposition
Bibliography :	- no compulsory book - lecture notes used by the professor constitute a syllabus, and are available on the iCampus platform before the beginning of the course; printing them out is highly recommended. - as facultative books: 'Understanding solids : the science of materials' de R.J.D. Tilley (Wiley, 2006), ISBN : 0-470-85276-3 'Introduction à la chimie du solide : cours et exercices corrigés' de L. Smart et E. Moore (Masson, 1997)n ISBN : 2-225-85621-4
Cycle and year of study :	> Master [120] in Chemistry and Bio-industries
Faculty or entity in charge:	AGRO