UCLouvain

lbrna2102

2026

Material surface characterisation

4.00 credits	45.0 h	Q2

Teacher(s)	Alsteens David (coordinator) ;Dupont Christine ;Gaigneaux Eric ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	General chemistry, general physics, physical chemistry
Main themes	The course relates surface characterization methods to associated physico-chemical phenomena of relevance in (bio)engineering. Three levels of characterization are covered, through in-depth study of three families of techniques. **Part A**: Chemical analysis of surfaces with an emphasis on X-ray photoelectron spectroscopy: principle, instrumentation, qualitative and quantitative aspects. **Part B**: Gas adsorption and its use to characterize the texture of solids: physical and chemical adsorption, adsorption isotherms, quantitative approaches. **Part C**: Electronic and scanning probe microscopies, emphasizing atomic force microscopy: instrumentation, imaging and force spectroscopy modes. The course combines the study of concepts, illustrations with practical examples and demonstrations on the instruments.
Learning outcomes	**At the end of this learning unit, the student is able to :** At the end of the course, the student will be able to: - Rephrase the physical principle of each characterization technique under study, by relating instrumental aspects to performances of the technique; - Interpret data obtained by these different techniques, taking into account the physical meaning of the results and limitations of each technique; - Justify the choice of one or several of these techniques in the frame of a given application in (bio)engineering (materials, catalysis, nano- and biotechnologies); - Evaluate the relevance and significance of scientific papers related to surface characterization by one of these techniques. More particularly, the student will have developed the ability to: Part A: - Interpret qualitatively and quantitatively XPS data obtained in a given context; 1 - Model XPS results in the case of heterogeneous samples. Part B: - Calculate the specific area of a material based on its adsorption-desorption isotherms (physisorption) , by making adequate use of the BET and t-plot models and concepts; - Describe the porosity of a material, both qualitatively (nature and shape of pores) and quantitatively (size and distribution of pore size), based on adsorption-desorption isotherms (physisorption) characteristics and their possible hysteresis by making use of Conway-Pierce, Dubinin-Raduskevich and t-plot models and concepts. Part C: - Distinguish and compare different imaging and spectroscopic modes in scanning probe microscopy, and interpret obtained images and spectra; - Choose the adequate imaging mode in a given practical application, by determining the sample characteristics to be quantified.
Evaluation methods	Paper analysis work during the semester (10% of final grade). Written exam (90% of final grade, 30% for each part A-B-C) including the presentation and application of concepts on which the different characterization techniques are based, the resolution of numerical exercises and data interpretation (in relationship with the above-mentioned learning outcomes).
Teaching methods	Lectures based on the presentation of concepts and on numerous examples of surface analysis applications, including exercises of data interpretation in a variety of contexts in (bio)engineering. Demonstrations in front of the instruments are proposed at the end of the semester.
Content	Introduction: Overview of the characterization of complex solids : texture, composition, structure, specific properties. Part A. Chemical analysis of surfaces. Context - Principles (electronic levels, elemental analysis of the surface) - Instrumentation - Qualitative aspects (main peaks and satellites, chemical shift and functional analysis)

	- Quantitative aspects (from the basic equation to the pragmatic approach, complex systems, models for interpretation). Part B. Gas adsorption and characterization of surfaces. Physical and chemical adsorption - Organized study of the differents types of adsorption isotherms: type II (BET), type IV (capillary condensation, porosity), type I (chemisorption, micropore filling), types III et V - Characterization of the texture of porous solids (know-how) - Equation of state - Heat of adsorption. Part C. Atomic force microscopy. Instrumentation - Topographic imaging: principles, applications - Force spectroscopy: principles, applications - Other imaging modes. Electronic microscopies
Inline resources	Moodle
Bibliography	Notes fournies par les professeurs et mises à disposition sur Moodle
Other infos	Each part of the course (A,B,C) may be followed separately. This course can be given in English.
Faculty or entity in charge	AGRO

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Chemistry and Bioindustries	BIRC2M	4		
Advanced Master in Nanotechnologies	NANO2MC	4		