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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. <b>Part A:</b> Chemical analysis of surfaces with an emphasis on X-ray photoelectron spectroscopy: principle, instrumentation, qualitative and quantitative aspects. <b>Part B:</b> Gas adsorption and its use to characterize the texture of solids: physical and chemical adsorption, adsorption isotherms, quantitative approaches. <b>Part C:</b> 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	<p><b>At the end of this learning unit, the student is able to :</b></p> <p>At the end of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>- Rephrase the physical principle of each characterization technique under study, by relating instrumental aspects to performances of the technique;</li> <li>- Interpret data obtained by these different techniques, taking into account the physical meaning of the results and limitations of each technique;</li> <li>- 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);</li> <li>- Evaluate the relevance and significance of scientific papers related to surface characterization by one of these techniques.</li> </ul> <p>More particularly, the student will have developed the ability to:</p> <p>Part A:</p> <ul style="list-style-type: none"> <li>- Interpret qualitatively and quantitatively XPS data obtained in a given context;</li> </ul> <p>1 - Model XPS results in the case of heterogeneous samples.</p> <p>Part B:</p> <ul style="list-style-type: none"> <li>- 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;</li> <li>- 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.</li> </ul> <p>Part C:</p> <ul style="list-style-type: none"> <li>- Distinguish and compare different imaging and spectroscopic modes in scanning probe microscopy, and interpret obtained images and spectra;</li> <li>- Choose the adequate imaging mode in a given practical application, by determining the sample characteristics to be quantified.</li> </ul>
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.

	<p>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).</p> <p>Part B. Gas adsorption and characterization of surfaces. Physical and chemical adsorption - Organized study of the different 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.</p> <p>Part C. Atomic force microscopy. Instrumentation - Topographic imaging: principles, applications - Force spectroscopy: principles, applications - Other imaging modes. Electronic microscopies</p>
<p>Inline resources</p>	<p>Moodle</p>
<p>Bibliography</p>	<p>Notes fournies par les professeurs et mises à disposition sur Moodle</p>
<p>Other infos</p>	<p>Each part of the course (A,B,C) may be followed separately. This course can be given in English.</p>
<p>Faculty or entity in charge</p>	<p>AGRO</p>

<b>Programmes containing this learning unit (UE)</b>				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Chemistry and Bioindustries	BIRC2M	4		
Advanced Master in Nanotechnologies	NANO2MC	4		