

5.00 credits




30.0 h + 15.0 h

Q2

**This biannual learning is being organized in 2026-2027**

Teacher(s)	Delcorte Arnaud ;Hackens Benoît ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Main themes	<ul style="list-style-type: none"> <li>• Introduction to Surface Science;</li> <li>• Electron spectrometries (LEED, AES, XPS) and Ion spectrometries (ISS, RBS, SIMS) ;</li> <li>• Near field microscopies (STM, AFM).</li> </ul>
Learning outcomes	<p><b>At the end of this learning unit, the student is able to :</b></p> <p><b>Contribution of the course to the program objectives</b></p> <ul style="list-style-type: none"> <li>• LO1.1, LO1.3</li> <li>• LO2.1, LO2.3</li> <li>• LO5.5</li> </ul> <p><b>Specific learning outcomes of the course</b></p> <p>a. Disciplinary Learning Outcomes: <i>Electron and ionic spectroscopies:</i> At the end of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• understand and explain the physical (or physico-chemical) mechanisms underlying the considered spectroscopic and spectrometric methods. These methods include electron spectroscopies (LEED-RHEED, AES, XPS-ESCA) as well as ionic spectroscopies (ISS, RBS) and mass spectrometries (SIMS, LDIMS, MALDI);</li> <li>• discuss the specifics of each method, compare the information they allow to obtain and their fields of application;</li> <li>• explain the principle scheme of the different instruments and describe their main components (ex. ion gun, electrostatic analyzer, multichannel detector);</li> <li>• identify the performance, the limitations (ex. sensitivity, quantification) as well as the possible artifacts related to the different analysis methods, be critical of the data interpretation;</li> <li>• provide examples of applications of the analytical techniques in the context of surface treatment and processing (ex. PVD, plasma treatments, thin layer deposition);</li> <li>• select an appropriate method for the structural or chemical analysis of an unknown solid sample;</li> <li>• justify the choice of method(s) to answer a problem in materials characterization (such as those encountered in the industrial context).</li> </ul> <p><i>Scanning probe microscopies (SPM):</i> At the end of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• identify and explain the physical, chemical and physico-chemical phenomenons at the basis of the functioning of scanning probe microscopies (STM, AFM, C-AFM, LFM, FMM, AM-AFM, FM-AFM, MFM, EFM, PFM, KPFM, ...);</li> <li>• describe the instrumentation and explain the functioning of these microscopies;</li> <li>• compare them regarding the physical, chemical or physico-chemical properties they allow to measure and map;</li> <li>• make and justify the choice of the adequate technique to characterize a specific property of a given material;</li> <li>• explain the artifacts that may bias this type of analysis and to criticize results obtained with one of those techniques on this basis.</li> </ul> <p>b. Transversal Learning Outcomes: At the end of the course, the student will be able to:</p> <ul style="list-style-type: none"> <li>• Critically discuss the experimental results with experts in the considered domains.</li> <li>• Write a concise lab experiment report, structured and adequately illustrated, describing the technical aspects of the experiments, from the sample preparation protocol to the obtained results, in a precise scientific language.</li> </ul>
Evaluation methods	Oral examination regarding the competencies that have to be acquired Laboratory reports Spectroscopy section (Delcorte): Possibility of presenting a seminar in front of the group (~1/2 of the points for this section).

Teaching methods	<p><b>Electron and ionic spectroscopies:</b>                  9 lectures of 2h each (including a 1 hour general introduction on surface science) and 2 laboratories illustrating selected techniques (instrumental aspects + data interpretation; reports asked to the students).</p> <p><b>Scanning probe microscopies (SPM):</b>                  5 lectures of 2h each and 2 laboratories illustrating two SPM techniques. For the laboratories, students of 2nd Master are encouraged to bring their own samples.</p>
Content	<ol style="list-style-type: none"> <li>1. Introduction to surface science</li> <li>2. Electronic and ionic spectroscopies                         <ol style="list-style-type: none"> <li>2.1. Surface crystalline structure with LEED</li> <li>2.2. Surface composition and chemistry with XPS/ESCA</li> <li>2.3. Chemical imaging and depth-profiling with SIMS</li> <li>2.4. High resolution elemental imaging with Auger</li> <li>2.5. Topmost layer analysis with ISS</li> <li>2.6. Quantitative analysis with Auger and XPS</li> <li>2.7. Fundamental aspects in (cluster) SIMS</li> </ol> </li> <li>3. Scanning probe microscopies                         <ol style="list-style-type: none"> <li>3.1. Scanning tunnelling microscopy and spectroscopy</li> <li>3.2. Atomic force microscopies                                 <ol style="list-style-type: none"> <li>3.2.1. Contact mode microscopies : C-AFM, LFM, FMM, CS-AFM, PFM, ...</li> <li>3.2.2. Resonant mode microscopies : AM-AFM, FM-AFM, MFM, EFM, KPFM, ...</li> <li>3.2.3. Instrumental aspects : scanner, probes, artifacts, ...</li> </ol> </li> </ol> </li> </ol>
Inline resources	Moodle site : <a href="https://moodle.uclouvain.be/course/view.php?id=1895">https://moodle.uclouvain.be/course/view.php?id=1895</a>
Bibliography	<p><b>Spectroscopies électroniques et ioniques :</b></p> <ul style="list-style-type: none"> <li>• Dias présentées aux cours, disponibles sur Moodle</li> <li>• Notes d'application des fabricants d'équipement</li> <li>• Liste d'ouvrages de référence, que les étudiants peuvent trouver à la bibliothèque / au laboratoire</li> </ul> <p><b>Microscopies à sonde locale (SPM) :</b></p> <ul style="list-style-type: none"> <li>• Notes de cours évolutives (syllabus) disponible au SICI et sur Moodle</li> <li>• Dias présentées aux cours, prospectus et notes d'application de fabricants d'équipement disponibles sur Moodle</li> </ul>
Other infos	It is highly recommended to have attended the LMAPR2011 « Methods of Physical and Chemical Analysis » course or an equivalent.
Faculty or entity in charge	FYKI

<b>Programmes containing this learning unit (UE)</b>				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Chemical and Materials Engineering	<a href="#">KIMA2M</a>	5		
Master [120] in Biomedical Engineering	<a href="#">GBIO2M</a>	5		
Master [120] in Physical Engineering	<a href="#">FYAP2M</a>	5		
Advanced Master in Nanotechnologies	<a href="#">NANO2MC</a>	5		