UCLouvain

# lmapr2631

*2023*

# Surface Analysis

| 5.00 credits | 30.0 h + 15.0 h | Q2 |
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| Teacher(s) | Delcorte Arnaud ;Nysten Bernard ; |
| Language : | English<br>> French-friendly |
| Place of the course | Louvain-la-Neuve |
| Main themes | • Introduction to Surface Science;<br>• Electron spectrometries (LEED, AES, XPS) and Ion spectrometries (ISS, RBS, SIMS) ;<br>• Near field microscopies (STM, AFM). |
| Learning outcomes | **At the end of this learning unit, the student is able to :**<br>**Contribution of the course to the program objectives**<br>LO : 1.1, 2.1, 2.3, 5.5<br>**Specific learning outcomes of the course**<br>a. Disciplinary Learning Outcomes:<br>Electron and ionic spectroscopies:<br>At the end of the course, the student will be able to<br>• 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);<br>• discuss the specifics of each method, compare the information they allow to obtain and their fields of application;<br>• explain the principle scheme of the different instruments and describe their main components (ex. ion gun, electrostatic analyzer, multichannel detector);<br>• 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;<br>• provide examples of applications of the analytical techniques in the context of surface treatment and processing (ex. PVD, plasma treatments, thin layer deposition);<br>• select an appropriate method for the structural or chemical analysis of an unknown solid sample;<br>• justify the choice of method(s) to answer a problem in materials characterization (such as those encountered in the industrial context).<br>1<br>Scanning probe microscopies (SPM):<br>At the end of the course, the student will be able to<br>• 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, ');<br>• describe the instrumentation and explain the functioning of these microscopies;<br>• compare them regarding the physical, chemical or physico-chemical properties they allow to measure and map;<br>• make and justify the choice of the adequate technique to characterize a specific property of a given material;<br>• explain the artifacts that may bias this type of analysis and to criticize results obtained with one of those techniques on this basis.<br>b. Transversal Learning Outcomes:<br>At the end of the course, the student will be able to:<br>• critically discuss the experimental results with experts in the considered domains;<br>• 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. |
| Evaluation methods | Oral examination regarding the competencies that have to be acquired<br>Laboratory reports<br>Spectroscopy section (Delcorte): Possibility of presenting a seminar in front of the group (~1/2 of the points for this section). |

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| Teaching methods | **Electron and ionic spectroscopies:**<br>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).<br>**Scanning probe microscopies (SPM):**<br>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. |
| Content | 1. Introduction ro surface science<br>2. Electronic and ionic spectroscopies<br>2.1. Surface crystalline structure with LEED<br>2.2. Surface composition and chemistry with XPS/ESCA<br>2.3. Chemical imaging and depth-profiling with SIMS<br>2.4. High resolution elemental imaging with Auger<br>2.5. Topmost layer analysis with ISS<br>2.6. Quantitative analysis with Auger and XPS<br>2.7. Fundamental aspects in (cluster) SIMS<br>3. Scanning probe microscopies<br>3.1. Scanning tunnelling microscopy and spectroscopy<br>3.2. Atomic force microscopies<br>3.2.1. Contact mode microscopies : C-AFM, LFM, FMM, CS-AFM, PFM, ...<br>3.2.2. Resonant mode microscopies : AM-AFM, FM-AFM, MFM, EFM, KPFM, ...<br>3.2.3. Instrumental aspects : scanner, probes, artifacts, ... |
| Inline resources | Moodle site : https://moodle.uclouvain.be/course/view.php?id=1895 |
| Bibliography | **Spectroscopies électroniques et ioniques :**<br>• Dias présentées aux cours, disponibles sur Moodle<br>• Notes d'application des fabricants d'équipement<br>• Liste d'ouvrages de référence, que les étudiants peuvent trouver à la bibliothèque / au laboratoire<br>**Microscopies à sonde locale (SPM) :**<br>• Notes de cours évolutives (syllabus) disponible au SICI et sur Moodle<br>• Dias présentées aux cours, prospectus et notes d'application de fabricants d'équipement disponibles sur Moodle |
| 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 |

## Programmes containing this learning unit (UE)

| Program title | Acronym | Credits | Prerequisite | Learning outcomes |
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| Master [120] in Chemical and Materials Engineering | KIMA2M | 5 | | |
| Master [120] in Biomedical Engineering | GBIO2M | 5 | | |
| Master [120] in Physical Engineering | FYAP2M | 5 | | |
| Advanced Master in Nanotechnologies | NANO2MC | 5 | | |