UCLouvain

lmapr2631

2025

Surface Analysis

5.00 credits	30.0 h + 15.0 h	Q2

Teacher(s)	Delcorte Arnaud ;Hackens Benoît ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Main themes	• Introduction to Surface Science; • Electron spectrometries (LEED, AES, XPS) and Ion spectrometries (ISS, RBS, SIMS) ; • Near field microscopies (STM, AFM).
Learning outcomes	**At the end of this learning unit, the student is able to :** **Contribution of the course to the program objectives** • LO1.1, LO1.3 • LO2.1, LO2.3 • LO5.5 **Specific learning outcomes of the course** a. Disciplinary Learning Outcomes: *Electron and ionic spectroscopies:* At the end of the course, the student will be able to: • 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); • discuss the specifics of each method, compare the information they allow to obtain and their fields of application; • explain the principle scheme of the different instruments and describe their main components (ex. ion gun, electrostatic analyzer, multichannel detector); • 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; • provide examples of applications of the analytical techniques in the context of surface treatment and processing (ex. PVD, plasma treatments, thin layer deposition); • select an appropriate method for the structural or chemical analysis of an unknown solid sample; • justify the choice of method(s) to answer a problem in materials characterization (such as those encountered in the industrial context). *Scanning probe microscopies (SPM):* At the end of the course, the student will be able to: • 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, ...); • describe the instrumentation and explain the functioning of these microscopies; • compare them regarding the physical, chemical or physico-chemical properties they allow to measure and map; • make and justify the choice of the adequate technique to characterize a specific property of a given material; • explain the artifacts that may bias this type of analysis and to criticize results obtained with one of those techniques on this basis. b. Transversal Learning Outcomes: At the end of the course, the student will be able to: • Critically discuss the experimental results with experts in the considered domains. • 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 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	**Electron and ionic spectroscopies:** 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). **Scanning probe microscopies (SPM):** 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 2. Electronic and ionic spectroscopies 2.1. Surface crystalline structure with LEED 2.2. Surface composition and chemistry with XPS/ESCA 2.3. Chemical imaging and depth-profiling with SIMS 2.4. High resolution elemental imaging with Auger 2.5. Topmost layer analysis with ISS 2.6. Quantitative analysis with Auger and XPS 2.7. Fundamental aspects in (cluster) SIMS 3. Scanning probe microscopies 3.1. Scanning tunnelling microscopy and spectroscopy 3.2. Atomic force microscopies 3.2.1. Contact mode microscopies : C-AFM, LFM, FMM, CS-AFM, PFM, ... 3.2.2. Resonant mode microscopies : AM-AFM, FM-AFM, MFM, EFM, KPFM, ... 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 :** • Dias présentées aux cours, disponibles sur Moodle • Notes d'application des fabricants d'équipement • Liste d'ouvrages de référence, que les étudiants peuvent trouver à la bibliothèque / au laboratoire **Microscopies à sonde locale (SPM) :** • Notes de cours évolutives (syllabus) disponible au SICI et sur Moodle • 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
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		