Surface analysis techniques and characterization of the structure

Academic Year: (2019 / 2020) **Review date: 06/05/2020 19:29:13**

Department assigned to the subject: Physics Department

Coordinating teacher: MUÑOZ SANTIUSTE, JUAN ENRIQUE

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Graduate studies in Engineering; Physics; Materials Engineering; Chemistry; Biomedicine; Aerospace

OBJECTIVES

BASIC COMPETENCES AND SKILLS

- Being equipped with knowledge allowing a basis or an opportunity to be original in the development and/or application of ideas, commonly in a research scenario.

- Capability of applying acquired knowledge and of solving problems in new or little-known situations within broader (or multidisciplinary) contexts related to their field of study.

- Capability of integrating knowledge and addressing the complexity of formulating judgements based on incomplete or limited information, taking due consideration of the associated social and ethical responsibilities associated to the application of those knowledge and judgements.

- Capability of communicating their knowledge and conclusions and ultimate reasons supporting them to both specialised and non-specialised audience in a clear and unambiguous way.

- Ability to learn and to continue the learning process, to a large extent, in an autonomous way.

GENERAL COMPETENCES AND SKILLS

- Understanding of principles related to Materials Science and Engineering in an industrial and research context.

- Knowledge of the appropriate disciplines needed to work in a laboratory; optimisation of results acquisition.

- Capability for teamwork in a research scenario.

- Ability to defend a research project and its derived results.

- Development of creative and decision-focused strategies with respect to problems related to design, fabrication and behaviour of materials.

SPECIFIC COMPETENCES AND SKILLS

- Detailed knowledge of the most common techniques for the characterisation of materials in research. Ability to have an autonomous use of associated instruments.

- Interpretation, discussion and conclusion devising from experimental data obtained with complex characterisation techniques that are common in the field of Materials Science and Engineering.

- Consolidation of specific research abilities in the field of Materials Science and Engineering.

- Scientific-technical knowledge and ability acquisition to solve specific problems associated to the field of materials development and characterisation.

LEARNING RESULTS

Passing this course implies that the students have learn to:

- Select an appropriate characterisation technique to retrieve a particular information about a given material.

- Know the theoretical basis and technical possibilities involved in the surface and structural characterisation of materials.

- Know each experimental technique detailed in the course syllabus and be familiar with their use.

- Use techniques for experimental data analysis.

- Interpret results obtained with the studied characterisation techniques.

- Draw general conclusions on physical and chemical properties of materials from results of different experimental measurements. Know how to correctly express the main implications of these results in practice.

DESCRIPTION OF CONTENTS: PROGRAMME

This course provides a general overview of the most widely used techniques for the characterisation of materials and their powers and possible limitations. To that end, its markedly experimental syllabus focuses on the development of skills for the management of structural and surface characterisation techniques as well as for the autonomous interpretation of results obtained with them, with the aim to integrate their meaning in a research context.

The syllabus is organised in 28 sessions of 1.5 hours, divided into 18 lectures and 10 laboratory practicals, according to the following structure:

LECTURES:

- Introduction to characterisation techniques. Measurement, result analysis and interpretation.
- Vacuum technology (techniques for preparation and maintenance of clean surfaces).
- Photoelectron Spectroscopy techniques for chemical analysis of surfaces (ESCA).
- Auger Electron Spectroscopy (AES) and Photoelectron X-ray Spectroscopy (XPS).
- Secondary Yield Emission (SYE).
- Transmission Electron Microscopy in materials I ans II: TEM, STEM. Analysis of EDX, EELS and Z-constrast.
- Materials characterisation with high energy ion beams.
- Introduction to Atom-probe tomography (APT). 3D atomic structure. Atomic Structure.
- Microstructural characterisation of bulk and thin films:
    - Crystal symmetries. X-Ray Diffraction.
    - Electron and neutron diffraction.
    - Electron Backscatter Diffraction (EBSD).
    - Microstructural characterisation techniques for polycrystalline materials.
    - Positron annihilation technique.
    - Raman and Infrared Absorption Spectroscopy.

PRACTICAL SESSIONS:

- X-Ray, electron and neutron diffraction.
- Description of elements in an ultra-high vacuum system. Characterisation of gases in the residual vacuum of an ultra-high vacuum system with a mass-spectrometer.
- Metal surface characterisation through the study of secondary electron emission.
- Positron annihilation technique.

- Characterisation of defects in solids with Optic Spectroscopy techniques. Optically active defects used as structural probes.
- Pin-on-disc technique.

LEARNING ACTIVITIES AND METHODOLOGY

This course provides a general overview of different techniques for crystallographic, microstructural and chemical analysis characterisation of materials. These are specialised techniques students can seldom get access to. Therefore it is important to make better known the equipments that can be used and the possible applications to specific needs in their professional/research career.

The methodology will be developed with respect to:

- Specialised researchers lectures, with audiovisual support. During these sessions, a detailed description of experimental techniques of structural and surface characterisation of materials will be given. Also, physical and chemical concepts and principles needed for the understanding of the techniques under study and for the analysis of experimental results will be introduced.

- Reading and critical analysis of scientific publications recommended by the lecturer.

- Gathering, interpretation and discussion of results from laboratory session activities, either individually or in a group.

- Experimental results processing, under the teacher supervision, using appropriate research techniques and equipment.

- Completion of reasoned reports on the experiments developed at the laboratory.

The formative activities this methodology will be used in include lecture and practical sessions, laboratory practice activities (in situ sessions), weekly tutoring sessions, work in groups or pairs and individual work.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

The course assessment will be carried out through:

* Involvement in lectures and laboratory sessions; capability of critical analysis of suggested topics (5 %)
* Completion of laboratory practice activities, including report writing, presentation and discussion on techniques used and results obtained during the sessions (55 %)
* Final exam, either written or online multiple-choice questions (40 %)

BASIC BIBLIOGRAPHY

- CAHN, R.W.; HAASEN, P. y KRAMER, E.J. Materials science and technology: a comprehensive treatment., Vol. 2A y 2B VCH, 1992-.

- H. SAISHO. Applications of Synchrotron Radiation to Materials Analysis Included in series: Analytical Spectroscopy., Library Edited by 9, 7, Japan.

- JOHN VICKERMAN. Surface Analysis-The Principal Techniques, John Wiley and Sons, 2003.

- Neil W. Ashcroft and N. David Marmin Solid Sated Physics, Thomson Learning .