UAB
Universitat Autònoma de Barcelona

Physics and Chemistry of Surfaces

Code: 106818
ECTS Credits: 6

2025/2026

Degree	Type	Year
Nanoscience and Nanotechnology	OB	3

Contact

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Teachers

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Teaching groups languages

You can view this information at the end of this document.

Prerequisites

None

Objectives and Contextualisation

The objective of this course is to introduce students to the highly relevant and interdisciplinary field of surface science, which lies at the intersection of physics, chemistry, and engineering.
The course will provide a detailed description of the surface structure of solids and its modification, as well as the main surface characterization techniques from structural, morphological, microstructural, and compositional perspectives.
It will cover the fundamental aspects of physicochemical phenomena occurring at liquid-gas, solid-liquid, solid-gas, and solid-solid interfaces. To address these topics, prior knowledge of chemistry and thermodynamics will be applied, particularly in relation to surface phenomena, interfaces, and heterogeneous catalysis.

Learning Outcomes

1. CM18 (Competence) Solve problems resulting from the nanoscale by using calculation and simulation tools.
2. CM20 (Competence) Assess the social, economic and environmental impact using nanomaterials and associated devices.

3. CM21 (Competence) Acknowledge the contribution women have made to the study of nanoscale phenomena.
4. KM30 (Knowledge) Describe the fundamental chemical-physical phenomena involved in creating, modifying, interacting and characterising surfaces and interfaces.
5. SM29 (Skill) Propose suitable techniques to characterise the structure, microstructure and composition of nanomaterials and nano-systems.
6. SM31 (Skill) Design nanomaterials and nano-systems that suit different technological specifications and uses.

Content

Topic 1. Introduction to surfaces
1.1. Concept and characteristics of surfaces
1.2. Importance and applications
1.3. Historical evolution

Topic 2. Structure of ideal solid surfaces
2.1. Structure, energy, and stability of surfaces
2.2. Relaxation and reconstruction
2.3. Surface notation
2.4. Structure of surfaces with adsorbates

Topic 3. Surface analysis and characterization techniques
3.1. Physical foundations of radiation-matter interaction
3.2. Diffraction and surface ordering techniques
3.3. Surface chemical characterization techniques
3.4. Microstructural characterization techniques
3.5. Applications and practical examples

Topic 4. Surface phenomena
4.1. Surface tension and surface free energy
4.2. Curved surfaces (Laplace and Kelvin equations)
4.3. Methods for measuring surface tension

Topic 5. Surface and interfacial tension
5.1. Surface tension in aqueous solutions
5.2. Gibbs isotherm
5.3. Work of adhesion and cohesion
5.4. Contact angle and Young's equation
5.5. Wettability
5.6. Detergency by surfactants

Topic 6. Adsorption phenomena
6.1. Definitions and gas/solid interaction
6.2. Adsorption isotherms (Langmuir, Temkin, Freundlich, BET)
6.3. Evaluation of specific surface area and pore size

Topic 7. Interaction of liquids with solids
7.1. Charged interfaces
7.2. Electrostatic models: Helmholtz-Perrin, Gouy-Chapman, Stern
7.3. Electrokinetic phenomena: electrochemistry and corrosion

Topic 8. Heterogeneous catalysis
8.1. Introduction to catalysis and types of catalysts
8.2. Kinetics of heterogeneous catalysis (temperature effects, Langmuir-Hinshelwood and Eley-Rideal models)
8.3. Industrial examples: cracking, reforming, catalyticoxidation

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Practice Activities	10	0.4	
Problem solving	14	0.56	
Theory letures	28	1.12	
tutorized learning	12	0.48	
Type: Autonomous			
Individual study	36	1.44	
Practice guides reading and preparation	6	0.24	
Practice report	12	0.48	
Problems solving	26	1.04	

Methodologies

The course consists of 28 hours of theoretical lectures, 14 hours of problem-solving sessions, and three laboratory practice sessions.

The teaching and learning methodologies include theoretical classes, problem-solving, laboratory work in pairs, research paper writing, autonomous and self-assessment activities, as well as personalized tutoring upon request - a highly recommended educational resource - and are complemented by specific bibliography related to the course syllabus.

Tutoring

The teaching staff will be available to answer students' questions. The use of this educational resource is strongly encouraged.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First Parcial Test	40	3	0.12	CM18, KM30, SM29
Group Problem Solution Report	10	0	0	CM18, CM20, CM21, KM30, SM29, SM31

Practice solution report	10	0	0	CM18, KM30, SM29
Secon Test	40	3	0.12	CM18, KM30, SM29

CONTINUOUS ASSESSMENT
To qualify for continuous assessment, students must:

- Complete two mandatory midterm exams, each accounting for 40% of the final grade.
- Submit the laboratory report -from the Chemistry lab- which will count for 10% of the final grade.
- Submit a report on a research project in surface science. This activity represents 10% of the final grade.

SINGLE ASSESSMENT
Students who choose the single assessment option must:

- Complete the Chemistry lab sessions and submit the corresponding report at least 48 hours before the scheduled date of the second midterm of the continuous assessment. This report will count for 10% of the final grade.
- Complete an individual practical assignment on XPS. The corresponding report will count for 10% of the final grade.
- Submit a report on a research project in surface science. This activity represents 10% of the final grade.
- Take a final exam covering the entire theoretical and problem-solving syllabus. This exam will take place on the same day as the second midterm of the continuous assessment and will account for 70% of the final grade.

REQUIREMENTS TO PASS
To pass the course, whether through continuous or single assessment, students must:

- Obtain a minimum score of 5 in the average of the two midterms or in the final synthesis exam.
- Achieve an overall grade equal to or greater than 5.0 out of 10.

If these requirements are not met but the student obtains a grade equal to or greater than 3.5, they will be entitled to a resit exam. This final exam will allow the student to pass the course with a grade of 5.0 out of 10. In the case of students under continuous assessment, they may retain the grade of any midterm exam, provided it is equal to or greater than 5.0 out of 10.

PLAGIARISM OR FRAUDULENT CONDUCT
If a student commits any irregularity that could significantly affect the evaluation grade, the activity will be graded with a 0, regardless of any disciplinary action that may follow. If multiple irregularities are detected in the same course, the final grade will be 0.

ARTIFICIAL INTELLIGENCE (AI)
The use of Artificial Intelligence (AI) technologies is allowed in this course as part of the development of assignments, provided that the final result reflects a significant contribution from the student in terms of analysis and personal reflection. The student must: (i) identify which parts were generated using AI; (ii) specify the tools used; and (iii) include a critical reflection on how these tools influenced the process and final outcome. Lack of transparency in the use of AI in this graded activity will be considered academic dishonesty and will result in a grade of 0, which cannot be recovered, or more severe sanctions in serious cases.

Bibliography

- Surface Analysis -The Principal Techniques 2nd Edition Editors JOHN C. VICKERMAN Manchester Interdisciplinary Biocentre,University of Manchester, U. S. GILMORE National Physical Laboratory, Teddington, UK: https://bibcercador.uab.cat/permalink/34CSUC_UAB/avjcib/alma991010344842806709

- K. Hermann. Crystallography and Surface Structure - 2e An Introduction for Surface Scientists and Nanoscientists; *Wiley-VCH Verlag GmbH.* ISBN: 978-3-527-33970-9, 978-3-527-69712-0, 978-3-527-69713-7, 978-3-527-69714-4.
- G.T. Barnes, I.R. Gentle, *Interfacial Science: an introduction* (2on ed.), 2010 Oxford University Press, ISBN 978-0-19-657118-5
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- M.E. Davis, R.J. Davis, *Fundamentals of chemical reaction engineering*. Chapter 5 - Heterogeneous Catalysis-.McGraw-Hill Higher Education , NewYork. (2003). https://bibcercador.uab.cat/permalink/34CSUC_UAB/avjcib/alma991010342206306709
- E. Otero, *Corrosión y degradación de materiales*. Editorial Síntesis

Software

NONE

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this link. To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	first semester	afternoon
(PLAB) Practical laboratories	1	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	2	Catalan	first semester	morning-mixed
(PLAB) Practical laboratories	3	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	afternoon