Course syllabus

Ytfysik
The Physics of Surfaces

EXTP95, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED N
Date of Decision: 2023-04-17

General Information

Main field: Nanoscience.
Elective for: F4, F4-nf, F4-axn, MNAV1, N4-nf, N4-m
Language of instruction: The course will be given in English on demand

Aim

The aim of the course is to give an introduction to surface science or more specifically to the properties and the chemistry of surfaces and interfaces at an atomic length scale. Surfaces and interfaces play a central role in a variety of modern technologies spanning from heterogenous catalysis, corrosion, electrochemical processes, printing, dyeing, and adhesion. In nanoscience surfaces play a central role, since the majority of the atoms are surface atoms. As an extreme example, all atoms in the 2D material graphene are surface atoms.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to explain how structure and properties are different for surfaces as compared to the interior of the material.

Competences and skills
For a passing grade the student must

- be able to give account for and apply the real space as well as the reciprocal space nomenclature used to describe surfaces and the adsorption on surfaces
- be able to interpret the results of surface science techniques such as XPS, LEED and STM as used in papers, patents, etc., and they should be able to assess the reliability of such results.
- be able towrite a well-structured project report which summarize, explain and analyse experimental and/or theoretical papers within the field of surface science.
- be able topresent the project report orally at a seminar in a well structured and pedagogical manner.
- be able toIndepently search and use information beyond the course literature.
- be able to Integrate the knowledge from the course in a scientific discussion.
- from a specific scientific question be able to choose the most relevant surface science technique to use.

Judgement and approach
For a passing grade the student must

- be able to explain and give examples of the importance of surface science in the society.
- be able to discuss and give examples of how surface science studies can lead to a more sustainable society and reduced environmental impact.

Contents

The course starts with an introduction to surfaces and their fundamental importance in physics, chemistry, nanoscience and biology. The introduction is followed by a basic discussion of surface structure, adsorption, surface reactions, and crystal growth. In particular, it is discussed how the physics and chemistry of surfaces (and 2d gases at surfaces) can differ fundamentally from those of the surfaces' 3d equivalents. In the remaining main part of the course, the experimental determination of surface structure, surfaces chemistry and surface is discussed and the following techniques are addressed:

Scanning tunnelling microscopy (STM, AFM, MFM), spectroscopy (AES, XPS), diffraction (LEED, SXRD), and microscopy techniques based on XPS, LEED, and SXRD. The course treats the following aspects:

- surface-specific problems in physics, chemistry, nanoscience, and biology • the description of surface structures, adsorption at surfaces, and alloys
- scanning tunnelling microscopy techniques for surface analysis.
- spectroscopy and diffraction techniqes for surface analysis
- newly developed methods for surface physics

The course is problem based, with overview lectures and exercise classes where the students work with problems directly connected to the lectures. Towards the end of the course the students choose a supervised group project. In the project a literature survey is combined with discussions with the supervisor. The aim of this project is to study a particular field/technique within surface science studies. The students present their project in a written report and orally at a seminar that is organized by the course responsible for all the students in the course.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: The examination is based on written examination at the end of the course, equivalent to 5 credits, and written and oral presentation of the project work at the end of the course, equivalent to 2.5 credits. To pass the entire course, passing marks on written exam and the project report and the oral presentation as well as participation in all compulsory parts of the course are required.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0122. **Name:** The Physics of Surfaces.
Credits: 5. **Grading scale:** TH. **Assessment:** Written examination
Code: 0222. **Name:** Project.
Credits: 2,5. **Grading scale:** TH. **Assessment:** Project presentation and report

Admission

Assumed prior knowledge: FFFF05 Solid State Physics or FFFF01 Electronic Materials.
The number of participants is limited to: No
The course overlaps following course/s: TEK177

Reading list

- According to literature list decided upon by the department. The list will be available at least five weeks prior to beginning of the course.

Contact and other information

Course coordinator: Jan Knudsen, jan.knudsen@sljus.lu.se
Further information: The course is given by the Faculty of Science and does not follow the study period structure.