Faculty of Health, Science and Technology
Physics

Syllabus

Surface Physics

Course Code: 2FYS003
Course Title: Surface Physics
Ytfysik
Credits: 7,5 ECTS
Degree Level: Doctoral

Course Approval
The syllabus was approved by the Faculty of Health, Science and Technology, 27 September 2017 and is valid from the spring semester 2018.

Language of instruction
English

Prerequisites
Admission to doctoral studies in physics or a Master's degree in physics. Also PhD students in other science and technology subjects may be admitted if they have basic knowledge of Solid State Physics.

Learning Outcomes
The aim of the course is for students to acquire advanced knowledge of the composition of the surfaces of solid materials, the physical and chemical processes on the surfaces and how these can be studied and applied. The course also aims to inspire students to adopt a scientific approach to research and to prepare them for doctoral studies.

Upon completion of the course, students should be able to:
- demonstrate basic knowledge of ultra-high vacuum technologies and its application in preparing and characterizing pure crystalline surfaces, as well as physical processes in the growth of ultra-thin films and technologies of the thin-film growth.
- give an account of the various types of surface morphologies, the atomic structure of surfaces, relaxation and surface reconstruction as well as the physical basis of these phenomena.

- give an account of the most important experimental technologies to characterize the structure of surfaces, such as scanning probe technologies, Auger electron spectroscopy, and electron diffraction technologies.
- describe surface scattering theory.
- give a detailed account of the LEED-technology and be able to analyze LEED-images.
- demonstrate advanced knowledge of the electronic structure of surfaces and the use of photoemission for experimental research on surface electronic state and surface band structure.
- demonstrate advanced knowledge of the physical basis of band bending with semiconductor surfaces and interfaces, metal-semiconductor interfaces, and the Schottky barrier.
- give an account of collective phenomena as well as adsorption and chemical reactions on surfaces.

Course Content
Instruction is in the form of lectures, seminars, and obligatory laboratory assignments.

Introduction to vacuum technology.
The atomic structure of surfaces. Reconstruction and relaxation. Structural research methods, especially electron diffraction. Preparation of surfaces, growth of ultra-thin films.
The electronic structure of surfaces. Spectroscopic research methods, especially photoemission, theory of angle-resolved photoemission. Surface band structure and surface states of various metal- and semiconductor surfaces.
Band bending and Fermi-level pinning of semiconductor surfaces. Metal-semiconductor interfaces, semiconductor heterostructures, the Schottky barrier.
Introduction to collective phenomena on surfaces and in interfaces, especially superconductivity and ferromagnetism.
Adsorption and chemical reactions on surfaces.

Reading List
See separate document.

Examination
Assessment is based on written and oral exams, hand-in assignments, lab reports, and written and oral presentation of a project.

Grades
One of the grades Fail (U) or Pass (G) is awarded in the examination of the course.

Quality Assurance
The course convenor has a duty to encourage a continuous dialogue on learning processes and goal fulfilment. A written evaluation is carried out at the conclusion of the course combined with a joint student-teacher discussion of all aspects commented on. The result of the evaluation is collated and made available in accordance with *The Higher Education* Ordinance, Chapter 1, § 14.

Course Certificate
Course certificate is issued on request.

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Reading List

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Books
Lüth, Hans. *Solid surfaces, Interfaces and Thin Films.*
Last edition. Springer-Verlag.

Reference literature
Ertl, Gerhard & Küppers, Jürgen. *Low Energy Electrons and Surface Chemistry*. Last edition. VCH Verlagsgesellschaft mbH.

Prutton, Martin. *Introduction to Surface Physics*. Last edition. Oxford University Press.

Venables, John A. *Introduction to Surface and Thin Film Processes*. Last edition. Cambridge University Press.

Woodruff, D. P. & Delchar, T. A. *Modern Techniques of Surface Science*. Last edition. Cambridge University Press.

Zangwill, Andrew. *Physics at Surfaces*. Last edition. Cambridge University Press.

Approval
Approved by the Faculty of Health, Science and Technology, 27 September 2017.