Principles of Materials Science

Programme course

6 credits

Materialvetenskapliga principer

TFYA95

Valid from: 2020 Spring semester

Determined by
Board of Studies for Electrical
Engineering, Physics and Mathematics

Date determined
2019-09-23

Main field of study
Applied Physics, Physics

Course level
Second cycle

Advancement level
A1X

Course offered for
- Master's Programme in Physics and Nanoscience
- Master's Programme in Materials Science and Nanotechnology
- Mechanical Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering

Specific information
The course is scheduled for the last time HT2020.

Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

Prerequisites
Calculus in one and several variables, linear algebra, and mechanics.

Intended learning outcomes

Materials science is a fusion of multidisciplinary theories and approaches since 1980s, and covers a wide range of scientific and engineering aspects. The primary goal of this course is to provide students a knowledge foundation of the quantum theory, solid-state chemistry, thermodynamics and kinetics, with the relevant mathematical tools and many application examples in materials science, in order to facilitate further studies and understand the inter-relationship among preparation techniques, structures, and properties of various materials, in particular crystalline solids and semiconductors in bulk, thin film, and nano-scale form. After successful examination the student should:

- be able to describe a material, from individual atoms, interatomic bonding, to crystalline periodic structure, with a quantum mechanic perspective
- understand how the structure dictates the properties of various materials at both microscopic and macroscopic levels
- be able to explain mass action and phase transformation processes of solid materials based on both thermodynamic and kinetic considerations
- understand the physics and chemistry behind some commonly used methods for materials synthesis and growth, and how the preparation technique affects the structures and properties of the material
- be able to design a process to prepare (synthesize or grow) the desired material, and calculate the synthesis (growth) rate using kinetic equations of the corresponding chemical reaction.

Course content

Quantum theory and atomic structures: Wave–particle duality, electron wavefunctions, the Schrödinger equation and basic quantum mechanics, the Bohr atom, the quantum description and electronic configurations of an atom.

Chemical bonding and molecular structures: Properties of bonded atoms, models of chemical bonding and bond hybridization, the Born-Oppenheimer approximation and molecular-orbital theory.

Solid-state chemistry: States of matter and phase transitions, nucleation and assembly of crystals, lattices and structural symmetry, fundamental properties of various matter.

Thermodynamics and kinetics in materials science: Chemical energies and the 1st law of thermodynamics, chemical equilibrium and the 2nd law of thermodynamics, chemical kinetics and reaction mechanisms.

Teaching and working methods

Lectures, problem solving classes, and laboratory experiments in small groups.

Examination

KTR1	Problem solving and presentation	0 credits	U, G
LAB1	Laboratory work	1 credits	U, G
UPG1	Hand-in assignments	1 credits	U, G
TEN1	Written examination	4 credits	U, 3, 4, 5

Homework assignment (6 sets) for grade 3 (if more than 70% approved). Optional written examination for higher grades.

Grades

Four-grade scale, LiU, U, 3, 4, 5

Other information

About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is Swedish, the course as a whole or in large parts, is taught in Swedish. Please note that although teaching language is Swedish, parts of the course could be given in English. Examination language is Swedish.
- If teaching language is Swedish/English, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English (depending on teaching language).
- If teaching language is English, the course as a whole is taught in English. Examination language is English.

Other

The course is conducted in a manner where both men's and women's experience and knowledge are made visible and developed.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent

Magnus Boman

Examiner

Wei-Xin Ni

Education components

Preliminary scheduled hours: 0 h
Recommended self-study hours: 160 h

Course literature

Books

Gersten, Joel I., Smith, Frederick W., (2001) *The physics and chemistry of materials* New York : Wiley, 2001
ISBN: 0471057940
Mortimer, Robert G., (2008) *Physical chemistry* 3rd ed. London : Elsevier, 2008.
ISBN: 9780123706171, 0123706173