Kurs-PM for ***SK2770 Introduction to Nanotechnology***

TNTEM1, HT21, P1, 5 ECTS

Content and learning outcomes
Course contents

This course builds around relevant knowledge from classical disciplines of physics, chemistry and biology to provide a fundamental understanding of the multidisciplinary Nanotechnology field of study. The course aims provide sufficient knowledge to the learner in order to broadly understand and appreciate the scientific and technological developments in nanotechnology. During the course students are expected to acquire basic knowledge of the physical phenomena, theoretical concepts and experimental techniques behind the ability to observe, fabricate and manipulate individual structures in the nanometer scales. Another aim of the course is to familiarize with the trends of the top-down approaches of materials fabrication especially in microelectronics and micromechanics with the bottom-up approaches from chemistry/biology; a development that is creating new and exciting cross-disciplinary technologies. Introduction to the past achievements and the current cutting edge scientific and technology developments in the nano-world will be presented to demonstrate the far-reaching potential of nanoscience and industrial applications of nanotechnology considering the ethics and societal impacts. A final goal is to give you an insight into complete systems where nanotechnology can be used to improve our everyday life.

Intended learning outcomes

Upon successful completion of the course, you should be able to:

- Describe developments in Nanotechnology and its impact.
- Describe materials and their properties at the atomic and nanometer level and the intimate relationship between material scale (nanostructure) and the properties/functionality of materials
- Explain the importance of the reduction in dimensionality, and its relationship to materials properties. Give examples on size-dependent phenomena.
- Describe solution and vapor growth techniques of 1D-2D nanostructures
- Describe fundamentals of nucleation growth
- Describe self-assembly, surfaces and interfaces in nanotechnology
- Explain top-down and bottom-up approaches for nanomaterial fabrication
- Describe and discuss Nanotechnology tools
- Describe societal impacts and ethics in Nanotechnology
- Explain underlying principles in products using nanotechnology

Course Disposition

The course material is planned as modules with specific learning goals. The goal is to provide the students with essential basic understanding of nanomaterials, nanotechnology, with its experimental and analytical toolbox.

There will be guest lecturers in the course by KTH faculty to prime few upcoming courses. Besides, alumni currently active in various research institutes and companies will give seminars/lectures where students will have a better feeling of the use of the knowledge spread in the curriculum in the Master Program in Nanotechnology.

- Introduction to the field of Nanotechnology
    - Definitions, Surface/Volume, size-dependent phenomena, etc.,

- Nanomaterials/devices synthesis/fabrication
    - top-down and bottom-up techniques / driving forces-principles
    - common colloidal techniques / strengths-limitations
        - (green chemistry – environmental impact)
    - common gas-phase techniques / strengths-limitations
        - micro- nano-fabrication
- Characterization toolbox for nanomaterials
- Materials and Devices; Enabled Technologies/Applications
- Industrialization, societal impact, ethics
- Guest Lecturers (KTH) and Alumni
    - Guest Lecturer: I. Sytjugov / Nanoelectronics overview / basic concepts
    - Guest Lecturer: M. Hammar / Semiconductor Devices (overview / basic concepts)
    - Guest Lecturer: K. Gallo / Quantum and Biophotonics Devices (overview / basic concepts)
    - Guest Lecturer: Alumni from Optics Components (II-VI Incorporated)
    - Guest Lecturer: Alumni from Optics Components (Mycronics)
    - Guest Lecturer: Alumni from RISE (nanomaterials – indsutrial relevance)
    - Guest Lecturer: Alumni from NKT (nanomaterials – indsutrial relevance)
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Literature and preparations

Specific prerequisites

Bachelor's degree in Physics, Electrical Engineering, Materials science, Chemistry or equivalent, including courses in mathematics corresponding to at least 20 ECTS credits and courses in physics corresponding to at least 30 ECTS credits.

Course Literature

- **Polymer Science and Nanotechnology: Fundamentals and Applications**
  Narain, Ravin (2020) [PART II: NANOTECHNOLOGY **CHAPTERS 15-18]**
  https://www-sciencedirect-com.focus.lib.kth.se/book/9780128168066/polymer-science-and-nanotechnology
- **Nanotechnology: Applications in Energy, Drug and Food**
  https://link-springer-com.focus.lib.kth.se/book/10.1007%2F978-3-319-99602-8

- **Nanotechnology: An Introduction**, Ramsden, Jeremy (2016) https://www-sciencedirect-com.focus.lib.kth.se/book/9780323393119/nanotechnology
- Nanomaterial for Biosensors (Chapter) https://link-springer-com.focus.lib.kth.se/chapter/10.1007/978-981-15-4742-3_3
- Lecture notes and reference literature.

In the Syllabus you can find a summary of the course as well as links to the Course PM and the course's intended learning outcomes.

Examination and completion

Grading Scale *

A, B, C, D, E, FX, F

Examination *

- TEN1 - Examination, 5,0 hp, betygsskala: A, B, C, D, E, FX, F

The exam will be an oral exam on the topics covered in the course, including the guest lectures.

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

There will be quizzes performed during the course hours and the students should have participated and passed at least 60% of the quizzes.

Successful completion of at least 60% of quizzes and the oral exam are obligatory for completion of the course.

Examiner

Muhammet Toprak toprak@kth.se

Ethical Approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.

Completion of the course

Regular final completion exam is set for week 44, October 22, 2021.
There will be a re-exam opportunity in December. If the student misses this opportunity then the exam can be taken in the following year's course offering.

Further information

Teaching Platform

Canvas will be used for the course materials and updates.
In case of remote or hybrid teaching, zoom platform will be used and links for respective course activities will be announced in the Canvas pages for the course.

Teacher

Prof. Muhammet S. Toprak / toprak@kth.se / 0735519358
Guest Teachers/Lecturers
Prof. Ulrich Vogt / ulrich.vogt@biox.kth.se
Prof. Katia Gallo / gallo@kth.se
Prof. Ilja Sytjugov /ilyas@kth.se
Prof. Mattias Hammar /hammar@kth.se

Communication with the teacher

Preferred communication platform for course related matters is Canvas. Please use “mail” function on canvas for your questions, with a clear subject line.

Course Evaluation and Course Analysis

At the end of the course period, an online questionnaire will be distributed to the students participating the course. Answers are anonymous, and if you would like to give feedback for the course development it is the right moment to have it documented. The answers given to the specific questions will be used to improve the course content and activities for the upcoming periods.

Add-on studies

For students aiming at specialization on the nanomaterials line of the Masters’ program, there are the following courses with the objectives of providing the students with a deeper chemistry knowledge and hands-on experience on nanomaterials synthesis -along with few characterization techniques:

SK2760 Chemistry of Nanomaterials (7.5p)
SK2773 Nanothermodynamics (7.5p)
SK2757 Project on Nanomaterials (7.5p)

Contact:

In this course you will meet Prof. Muhammet Toprak as the main teacher and examiner. Contact details are as follows:

Muhammet Toprak; toprak@kth.se

You find information about the course, and course content, in Canvas under Modules. There you also find the Zoom-link for our scheduled activities.

All announcements will be made via Canvas under Announcements.