FSK3900 Nanomaterial Chemistry 6.0 credits

Nanomaterialkemi

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

Course syllabus for FSK3900 valid from Autumn 2018

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

Inskriven som forskarstuderande.
Grundläggande inledande kemi eller materialvetenskap kunskaper på universitetsnivå.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After a successful completion of the course, students should be able to:

- Describe and distinguish between different models of chemical bonding (ionic, covalent, Lewis, metal) and propose dominant bonding type in compounds.
- Establish Lewis structures, including resonance and alternative forms, determining VSEPR-formulas and geometry of chemical compounds and (for simple compounds) indicate hybridization.
- Draw the shape of simple molecules, show the bonding scheme and charge on each atom.
- Describe bottom-up and top-down strategies for making nanostructured materials.
- List solution based techniques used for the fabrication of nanomaterials.
- Describe co-precipitation technique and compare it with other solution based techniques.
- Describe sol-gel technique and compare it with other solution based techniques.
- Describe microemulsion synthesis technique and compare it with other solution based techniques.
- Explain the underlying principle of morphology and size control in solution-based fabrication techniques.
- Describe redox reactions and explain the princimples of electrochemical process for fabrication of nanostructured materials.
- Describe self-assembly route, explain the underlying principle for the fabrication of nanostructured materials.
- Give examples of nanostructured materials fabricated via self-assembly route.
- Describe directed-assembly route, explain underlying principles.
- Describe mesocrystals and their formation using self-assembly principles.
- Suggest possible strategies for fabrication of a nanomaterial with given complexity.
- Design a strategy/strategies for the fabrication of nanomaterials with defined composition, morphology and size constratints.
- Understand and compare chemicals used from environmental and sustainability perspective
- Describe green chemistry and its connection to sustainable development
- Finding chemical information in the literature on physical fabrication routes, compile and present this in writing and orally.
- Present own research with details of fabrication strategies used within

Course contents

This course reviews strategies for fabrication of nanostructured functional materials from building blocks with at least one dimension less than 100 nm. It aims at teaching the students a variety of solution based chemical techniques that are commonly used for the fabrication of nanostructured materials. A general introduction on materials chemistry starting from the atomic level to the formation of crystals/solids and crystal structures, intermolecular and intramolecular forces, molecular structures, stoichiometric calculations will be introduced in the beginning. Bottom up strategies for the fabrication of nanostructured materials with a higher flexibility of controlling materials' microstructure will be emphasized. Solution based techniques will be prioritized in order to emphasize the significance of prior chemical knowledge in making the desired materials. Specifically the following nanomaterials fabrication techniques will be covered: Solution co-precipitation, thermodynamic modeling;

sol-gel synthesis; redox reactions and electrochemical synthesis; microemulsion synthesis. Self-assembly, or directed assembly, process, related chemical principles, and its use for the fabrication of higher order nanostructures will be presented. After introducing all these techniques, pros and cons will be discussed and several examples of their implementation in materials science will be presented. Green chemistry concepts and its impact from a sustainability perspective will be introduced.

Disposition

The course is run together with the course SK2760 - Nanomaterial Chemistry.

Course literature

Different sections of the course will require different resources. Handouts and related up-to date literature resources will be utilized and distributed during classes. The following text-books will be useful and will be followed for the indicated topics:
1. General Chemistry and principles: Burdge, J: Chemistry, 2nd Edition. McGraw-Hill, 2010.
2. Sol-gel synthesis: Sol-Gel Science: The Physics and Chemistry of Sol-gel Processing. Brinker, C.J.; G.W. Scherer, Academic Press, 1990.
3. Applied Electrochemistry. Thompson, Maurice de Kay, The MacMillan company (available on line at: http://www.archive.org/stream/appliedelectroch00thomrich#page/n5/mode/2up) Chapter III, IV, V.
4. Online source at: http://www.tannerm.com/electrochem.htm
5. Virtual Chemistry Textbook: A reference text for General Chemistry by Stephen Lower. Available online at: http://www.chem1.com/acad/webtext/virtualtextbook.html

Examination

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.

If the course is discontinued, students may request to be examined during the following two academic years.

Assignments: INL1, INL2, INL3, INL4, INL5: (compulsory to hand in)
Project Report
RED1: Final exam: in the form of project presentation - oral exam
RED2: Present own research and methodologies of fabrication in detail

Other requirements for final grade

To pass the course all the assignments have to be handed in (the best two will be counted for grading), project report satisfying the required quality criteria prepared and handed in, oral presentations have to be performed.

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.