Kurs-PM for ***SK2772 Chemistry for Nanotechnology***

TNTEM1, HT21, P1, 5 ECTS

Content and learning outcomes

Course contents

An essential pre-requisite nanotechnology research area is the reliable synthesis/fabrication routes to well defined nanostructures/nanoparticles, their modification and functionalization as well as their organization into larger hierarchical and functional structures.

This course aims at introducing the fundamentals of thermodynamics and kinetics in solution phase nanofabrication processes. Definitions and calculations using the concepts of Enthalpy (H), Entropy (S) and Gibbs Free Energy (G) will be discussed and their role on reactions will be investigated with examples. Basic chemical calculations, dissolution vs. precipitation processes will be investigated from solubility equilibrium aspects. As a common route to substrate processing electrochemical processes, aka redox reactions, along with the governing principles will be introduced. Electro-less, electrochemical and electrophoretic processes will be discussed. Examples on the control and use of electrochemical processes on the directional, or selective, etching or deposition will be presented. Some common clean room substrate treatment processes will be discussed emphasizing the type and risks associated with the chemicals used.

Intended learning outcomes

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

- Describe fundamental thermodynamic parameters for chemical processes and their interrelation
- Explain enthalpy driven processes vs entropy driven processes
- Describe precipitation process and explain underlying principles for size and morphology control
- Apply solution chemical processes for nanomaterial fabrication, directional etching/deposition
- Recognize the risks of handling chemicals with various degrees of content and strength

Course Disposition

The course material is planned as modules with specific learning goals. During the advancement of the course it will be required to have the skills from the previous modules to be able to follow-up the course content. The goal is to provide the students with essential basic understanding and skills for chemical processes, and chemicals used in clean room and other nanomaterial synthesis techniques in connection to solution thermodynamics and equilibrium processes. Students will also choose a syntheses topic about which they are going to make a presentation, discussing the chosen methodology in terms of the aspects studied in the class.

Detailed Schedule - HT21

Date	Time	Activity & location	Teachers	Contents, Literature
Week 35 2020				
Mon 30 Aug	13:00 - 15:00	LE FB54	MT	Introduction, Diagnostic Test **(L0)** Chemicals, classifications, risks, handling **(L1)**
Thu 2 Sep	10:00 - 12:00	LE FB54	MT	Basic Chemical Calculations, Stoichiometry **(L2)**
Week 36 2020				
Mon 6 Sep	13:00 - 15:00	LE FB55	MT	Empirical Formula, Molecular Formula, Chemical Equations **(L3)**
Thu 9 Sep	10:00 - 12:00	LE FB55	MT	Fundamentals of Thermodynamics and Kinetics **(L4)**
Week 37 2020				
Mon 13 Sep	13:00 - 15:00	LE FB54	MT	Calculations using Enthalpy, Entropy, Gibbs Free Energy **(L5)**
Week 38 2020				
Mon 20 Sep	13:00 - 15:00	LE FB54	MT	Solution Equilibrium - Solubility -Acid-Base Equil - NP Synthesis **(L6-L7)**
Thu 23 Sep	10:00 - 12:00	LE FB54	MT	Acid-Base Equilibrium - NP Synthesis **(L6-L7)**
Week 39 2020				
Thu 30 Sep	10:00 - 12:00	LE FB54	MT	Silicon Wet Processing (Directional vs. Selective Etching) **(L8)**
Week 40 2020				
Mo 4 Oct	13:00 - 15:00	LE FB55	Students MT	Student presentations
Wed 6 Oct	10:00 - 12:00	LE FB55	Students MT	Student presentations
Thu 7 Oct	10:00 - 12:00	LE FB54	Students MT	Student presentations
Week 41 2020				
Mon 11 Oct	13:00 - 15:00	LE FB55	Students MT	Student presentations
Thu 14 Oct	10:00 - 12:00	LE FB55	Students MT	Student presentations
Fri 15 Oct	10:00 - 12:00	LE FB55	MT	Green Chemistry **(L9)** Overview of Solution Chemical synthesis techniques **(L10)**
Week 42 2020				
Thu 21 Oct	08:00 - 13:00	EX FB54, FB55		FINAL EXAM
Week 51 2020				
Tue 21 Dec	08:00 - 13:00	OM FB55		RE-EXAM

Abbreviations

MT	Muhammet Toprak / toprak@kth.se / 0735519358
LE	Lecture
EX / OM	Exam / Re-exam
L0 – L10	Lecture materials at CANVAS

Addresses:

FB54, FB55,	Roslagstullsbacken 21, Main Building, floor 5, AlbaNova

Project Presentation Topics (Reference Materials are available at CANVAS)

1.	Thermolysis / Hot-injection vs heat-up method		Ref material at CANVAS
2.	Polyol synthesis		Ref material at CANVAS
3.	Biological Synthesis – Bacteria	(Book p25-42)	Ref material at CANVAS
4.	Biological Synthesis – Virus	(Book p42-53)	Ref material at CANVAS
5.	Biological Synthesis – Plant extract	(Book p79-93)	Ref material at CANVAS
6.	Biological Synthesis – Zoosynthesis	(Book p103-127)	Ref material at CANVAS
7.	Ultrasound synthesis – Sonochemistry		Ref material at CANVAS
8.	Flame Synthesis / Spray pyrolysis		Ref material at CANVAS
9.	Laser ablation in solution		Ref material at CANVAS
10.	Electrospinning		Ref material at CANVAS
11.	Mechanochemical synthesis		Ref material at CANVAS
12.	Electro explosion / Electric pulsed power synthesis		Ref material at CANVAS
13.	Solution Combustion synthesis		Ref material at CANVAS
14.	Periodic mesoporous materials synthesis		Ref material at CANVAS
15.	Sol-gel Synthesis		Ref material at CANVAS

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

- Nanomaterials and Nanochemistry, C. Brechignac P. Houdy M. Lahmani (Eds.), ISBN 978-3-540-72992-1 Springer Berlin Heidelberg New York (available on line at the following address: http://folk.ntnu.no/fredrol/Nanomaterials%20and%20Nanochemistry.pdf)
- Nanochemistry: A Chemical Approach to Nanomaterials by Geoffrey A Ozin, ISBN: 9781847558954, RSC Publishing
- Lecture notes and reference literature.

Examination and completion

Grading Scale *

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

Examination *

- INL1 - Assignment, 1,0 hp, betygsskala: P, F
- TEN1 - Examination, 4,0 hp, betygsskala: A, B, C, D, E, FX, F

The examination is composed of two parts, one part being the Projet Presentation and the second part as the oral exam for this period -due to the current situation with Covid-19

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
All assignments, Project presenattion and 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 21, 2021.
There will be a re-exam opportunity on December 21, 2021. 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

Muhammet Toprak / toprak@kth.se / 0735519358

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
SK2773 Nanothermodynamics
SK2757 Project on Nanomaterials