

CHEM-C3410 Nanomaterials

Course Information 2020: Timetable, Assessment, Tasks

NOTE! If you have done CHEM-E5120 Nanomaterials and Interfaces earlier, you cannot add Nanomaterials to your degree

Teachers

Teacher – in – charge:

University Lecturer Kirsi Yliniemi

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Course Assistants

B.Sc. Karri Heikkilä (karri.heikkila@aalto.fi)

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After this course you can

1. Combine **physical and chemical principles** that lead to the **characteristics of nanoscale materials**

2. Understands the origin of **self-assembly**

3. Determine the suitable **characterization methods** at nanoscale

4. **Analyse** measurement data at basic level

Course Schedule 2020

THEME	LECTURE 1 Mon 10-12	Science Project TUE 10-12	LECTURE 2 Wed 10-12	EXERCISE SESSION Thu 10-12
Introduction & Stability	26.10. Introduction to Nanoscale Science	Choose Science Project group and topic	28.10. Forces and Stability	29.10. Exercises (DL: 1 st Nov)
Self-Assembly & Nanomaterials	02.11. Adsorption, Self-Assembly and Nanochemistry	03.11 Discussion 1: Ask more about topic	04.11. Special Nanomaterials	05.11. Exercises (DL: 8 th Nov)
Properties at Nanoscale + characterization	09.11. Properties at Nanoscale I: Electrical Properties		11.11. AFM+STM (prof. Peter Liljeroth)	12.11. Exercises (DL: 15 th Nov)
Properties at Nanoscale	16.11. Properties at Nanoscale II: Optical Properties 1st Version of Science Project, DL 16th Nov	17.11. Discussion 2: Present your 1 st version	18.11. Properties at Nanoscale III: Mechanical and Thermal	19.11. Exercises (DL: 22 nd Nov)
Nanotoxicity	Properties at Nanoscale IV: Magnetic and Dielectric		25.11. Nanotoxicity and nanosafety	26.11. Exercises (DL: 29 th Nov)
OUTCOME OF THE GROUP WORK	30.11. Course Review	01.12. Discussion 3: Present your final version	02.12. Discussion 4 (if needed)	Final Version of Science Project, DL: 6th Dec

Course Material

The lecture slides are NOT enough
as a reading material for the exam

➤ **Read the course books and related papers (links in MyCourses)**

1. G. Cao, Y. Wang: *Nanostructures and Nanomaterials - Synthesis, Properties and Applications*, World Scientific 2004.
2. M.F. Ashby, P.J. Ferreira, D.L. Schodek: *Nanomaterials, Nanotechnology and Design - An Introduction for Engineers and Architects*, Elsevier 2009.
3. R.J.D. Tilley – *Understanding Solids* (2013) John Wiley & Sons.
4. Barry W. Ninham and Pearandrea Lo Nostro: *Molecular forces and self-assembly in Colloid, Nano Sciences and Biology*, Cambridge University Press 2010.
5. B.S. Murty, P. Shankar, B. Raj, B.B. Rath, J. Murday, *Textbook of Nanoscience and Nanotechnology*, Springer 2013.
6. M Scarselli, P. Castrucci, M. De Crescenzi, Electronic and optoelectronic nano-devices based on carbon nanotubes, *J. Phys.: Condens. Matter* **24** (2012) 313202.
7. A. K. Geim, K. S. Novoselov, The rise of graphene, *Nature Materials* **6** (2007) 183-191:
8. H. Li, P.D. Han, X.B. Zhang, M.Li, Size-dependent melting point of nanoparticles based on bond number calculation, *Materials Chemistry and Physics* **137** (2013) 1007-1009
9. H. Hu, D. Li, Y. Gao, L. Mu, Q. Zhou, Knowledge gaps between nanotoxicological research and nanomaterial safety, *Environment International* **94** (2016) 8–23.

Lecture	M.F Ashby et al., Nanomaterials, Nanotechnologies and Design: Introduction to Engineers and Architects	G. Cao et al., Nanostructures and Nanomaterials Synthesis, Properties and Applications	B. W. Ninham et al., Molecular forces and self- assembly in Colloid, Nano Sciences and Biology	RD.J. Tilley – Understanding Solids or Selected Papers (links in MyCourses)
1: Introduction		Ch. 1-2.3 (until p. 27)		
2: Forces and Stability		Ch. 2.3 (from p. 27) – 2.6	Ch. 2.1.1-2.1.2, 2.2.7	
3: Adsorption, Self- Assembly, 0D-3D		Ch. 5.8	Ch. 9.1-9.7	
4: Special Nanomaterials		Ch. 6.2.1, 6.2.3. Ch. 6.3.1-6.3.2.		M Scarselli et al, <i>J. Phys.: Condens. Matter</i> 24 (2012) 313202 : Ch. 1-3. (read still the 1st column in p. 4, in pdf) A. K. Geim et al., <i>Nature materials</i> 6 (2007): pp. 183-186 (up to “Chiral Quantum Effects”) and 189 – 191 (from “2D or not 2D”)
5: Properties I – Electronic	Ch. 7.3, 7.5			R.J.D. Tilley – Understanding Solids: Ch. 13.5 Nanostructures and Quantum Confinement of Electrons (863-866)
6: AFM + STM				Lecture Slides
7: Properties II - Optic	Ch. 7.3, 7.5			R.D.J. Tilley – Understanding Solids: Ch. 14.10 Nanostructures (987-989)
8: Properties III - Mechanical and Thermal	Ch 7.1.-7.2.	Ch. 8.4.1 -8.4.2		H. Li, P.D. Han, X.B. Zhang, M.Li, <i>Materials Chemistry and Physics</i> 137 (2013) 1007-1009: Ch. 1-2
9: Properties IV – Magnetic and Dielectric	Ch. 7.4	Ch. 8.4.5-8.4.6		
10: Nanotoxicity and Nanosafety				B.S. Murty, P. Shankar, B. Raj, B.B. Rath, J. Murday, <i>Textbook of Nanoscience and Nanotechnology</i> , Springer (2013), Ch. 7. X. Hu, D. Li, Y. Gao, L. Mu, Q. Zhou, <i>Environment International</i> 94 (2016) 8–23: Ch. 1-3
TO THE EXAM	7.1-7.5	1-2; 5.8; 6.2.1; 6.2.3; 6.3.1.- 6.3.2; 8.4.1.- 8.4.2; 8.4.5- 8.4.6	2.1.1-2.1.2; 2.2.7; 9.1-9.7	SELECTED CHAPTERS from ALL ABOVE

Course assessment: Max. Points from Different Tasks

SCIENCE PROJECT

Exercises	Meeting Activity	1 st version	Final Version	Online Group Exam	Total
15	3	3	10	20	51
			<i>Compulsory</i>	<i>Min. 7 p</i>	<i>Pass: 23 p</i>

Lectures

- A/B/C voting in ZOOM etc. \approx **most important concepts**

Lectures are NOT compulsory but recommended

Exercises

All exercises are available in MyCourses at the start of the course

- **Submit the answers weekly to MyCourses (DL: Sunday 23:59)**

The correct answers will be published after the DL so submit the answers even if you would not have finished it all.

Exercises and Exercise Sessions are NOT compulsory

Exercises

1. **Make in your own time**

- Typically: 2 calculations + 1 quiz/essay in each week

2. **Exercise sessions**

- A place where you can ask help & get hints
- Each week we'll concentrate on the exercises related to that week's topics

3. **The correct answers will be available in MyCourses after the submission dates**

Exercises

Submission of answers

1. Calculations are hand-written, quiz/essay written directly to MyCourses
2. Take a photo from each, **hand-written** answer
3. Combine to ***a pdf file***
4. Submit to MyCourses
 - Submission boxes for pdf files
 - Submission of quiz/essay directly to MC

****The answers must be clearly visible (easy to read) in the pdf files***

ONLINE Group Exam (max. 20 points)

COURSE EXAM

10th December, 09:00-13:30
- Choose the group in MyCourses

MAKE-UP EXAM

23rd February 2021, 08:00-12:30
- Choose the group in MyCourses
- Sign also in WebOODI

- **Exam is done in groups of 1 – 3 persons**
 - The whole group will get the same points
 - The group must be chosen in MyCourses a week before the exam
 - **CHOOSE THE GROUP ALSO IF YOU TAKE THE EXAM ALONE (OTHERWISE YOU CANNOT SUBMIT THE EXAM TO MYCOURSES)**
 - If someone randomly joins your group: inform Kirsi Yliniemi 6 days before the exam and the person is removed (he/she will do the exam alone)
- **All communication is allowed within the group, but communication is NOT allowed outside the group**
- **You are allowed to use course material or google but you are NOT allowed to ask help outside your group (not even in chats, forums etc.)**

ONLINE Group Exam (max. 20 points)

COURSE EXAM

- 10th December, 09:00-13:30
- Choose the group in MyCourses

MAKE-UP EXAM

- 23rd February 2021, 08:00-12:30
- Choose the group in MyCourses
- Sign also in WebOODI

How does this work?

- Questions are published in MyCourses at the start of the exam
- Answer to the questions as a group
- Combine answers **to ONE PDF file and submit to MyCourses** before the exam time is finished
 - For essays etc. text you may use computer (it is actually preferred)
 - Calculations you can do by hand: take a photo and embed to the Word-document on which you have written essay answers
 - Create then a pdf.

HINT! Save the last 30 mins of the exam time to combine answers, create pdf and submit to MyCourses

The exam is planned so that 4 h is enough to answer to the questions.

Emergencies during the exam

E.g. MyCourses is not responding... or other emergencies

- CALL Kirsi Yliniemi (+358 50 592 3690)
- You are provided a licence to submit the answers by email
- Answers must be sent before the end of exam time
- However, you **MUST** submit exam answers **ALSO** to MyCourses **as soon as possible**
- **ONLY MYCOURSES SUBMISSIONS WILL BE GRADED**

Science Project (Group Work): Research Plan

Write Research Plan of a selected nano topic

- **Introduction (2-3 pages)**
 - Why this topic is interesting from global and society point of view? How about research point of view and what kind of previous research has been done in this topic? What is your MAIN goal in this work: this only shortly, with 2-4 sentences in the end of Introduction?
- **Research Questions and Main Hypothesis (1-2 pages)**
 - What are the specific 2-4 research questions you want to solve?
 - What are your hypothesis/scientific principles of how system should behave, i.e. what is already known?
- **Research Plan and Timetable (no page limit)**
 - Which measurements and why?
 - Which chemicals? Safety considerations?
 - Which tasks are needed to answer to the research questions?
 - Timetable
- **Summary (no page limit)**
- **References**

Plan appr. of **ONE MONTH** of active lab time for one person (4 weeks x 5 days x 8 hours)

Science Project: Example of timetable

	WEEK 1	WEEK 2	WEEK 3	WEEK 4
Research Question 1: What is the role of surface?				
TASK 1.1: Effect of topography				
TASK 1.2: Effect of surface chemistry				
Etc.				
Research Question 2:....				
TASK 2.1				
Etc.				

Plan appr. of **ONE MONTH** of active lab time for one person (4 weeks x 5 days x 8 hours)

Science Project Steps (1/2)

STEP 1: Choose one of the following topics:

- 1. Colloidal Lithography**
(Prof. Franssila)
- 2. Template-assisted/patterned nanosurfaces by EDRR**
(Dr. Yliniemi)
- 3. Photothermal nanoporous materials for solar steam production**
(Prof. Vapaavuori)
- 4. Controlling the Morphology of Block Copolymer Micelles**
(Dr. Sammalkorpi) – **BOTH experimental and computational plans are ok**
- 5. Synthesis of nanomaterial at low pressure (with or without plasma) processes** (Prof. Koskinen)

Choose also your group



Science Project Steps (2/2)

STEP 2: Find and Read Material of your topic

STEP 3: Ask many questions and get more knowledge of the topic in Discussion 1 (TUE 3rd Nov)

STEP 4: Write the 1st version before Discussion 2 (MON 16th Nov)

STEP 5: Introduce your preliminary plan, get feedback and ask lots of clarifying questions in Discussion 2 (TUE 17th Nov)

STEP 6: Write and expand your Research Plan

STEP 7: Present your final Research Plan and get final suggestions for improvement in Discussion 3 (TUE 1st Dec)

STEP 8: Tweak the final Research Plan based on advice in Discussion 3 and submit the final version of Science Project (SUN 06th Dec)

Optional: Do you want to perform the work later on?

**Additional (individual) offer:
Perform the work in one of the following courses**

Bachelor students:

- CHEM-C3000 Kemiantekniikan tutkimusprojekti (5 cr or 10 cr)
- If you are “Kemia ja materiaalitiede pääaineopiskelija”, this can be also experimental part of your bachelor work

Master students:

- CHEM-E5200 Personal Research Assignments in Functional Materials (5 cr or 10 cr)

- This offer is only valid if the professor/research group in question has/have supervision time: discuss with the topic supervisor
- **The fact whether you will/want to perform the work or not in CHEM-C3000 or CHEM-E5200 does NOT affect grading in Nanomaterials course**

NOTE! Micelle work performance is computational only

Another optional possibility: Do you have your mandatory foreign language credits?

If not, or if you'd just like to hone your skills a bit more just for fun :-), you're warmly welcome to attend the English course LC-1117 H05.

This is a very special course **integrated specifically with your Nanomaterials course (i.e. Science Project)**, e supporting you with the CHEM-C3410 course assignments.

INTERESTED?

More details can be requested from the English lecturer pia.lappalainen@aalto.fi .

She hopes to see you in October!



Science Project Deadlines and Assessment 2020

TASK	Deadline	Other Info	Assessment
Topic and pair selection	THU 29th October		N/A
Preparing for 1 st Discussion	TUE 03rd November	Find and read some material beforehand: <i>what is the topic about, what equipment could be used, why is this interesting?</i> MAKE NOTES TO YOURSELF SO YOU CAN ASK MORE IN DISCUSSION 1	Affects Meeting Activity (max. 3 p)
1 st Version Submission	MON 16th November	Submit 1st Version to MyCourses <i>(incl. why this is interesting, what are your research questions, which techniques, why, timetable)</i>	Max. 3 p
Preparing for 2 nd Discussion	TUE 17th November	Present the 1st Version = Title slide + 6 slides: <i>Slide 1: what and why? + Slide 2: Research questions and hypothesis + Slides 3-5: how? + Slide 6: timetable</i> Get Feedback from your plan	Affects Meeting Activity (max. 3 p)
Preparing for 3 rd Discussion	TUE 01st December	Write the final Research Plan Present the final version = 10 min slide show Get final comments in DISCUSSION 3	Affects Meeting Activity (max. 3 p)
Final Science Project	SUN 06th December	Submit Final Research Plan to MyCourses: 2-3 pages Introduction <i>(incl. Main Objectives and Motivation)</i> 1-2 pages of Research Questions and Hypotheses Research Plan <i>(incl. equipment and synthesis methods and why, which chemicals, safety issues, timetable)</i> Summary	Max. 10 p

Plan appr. of **ONE MONTH** of active lab time for one person (4 weeks x 5 days x 8 hours)