

Functional Inorganic Materials

CHEM-E4215 (5 cr)

Lectures (12 x): Monday 10.15 – 12.00
Thursday 10.15 – 12.00

Two different lecture halls (for details, see see the next slide)

Lecturers: Maarit Karppinen
Antti Karttunen

- Lectures: 12 x 2 h
- Home problem solving 40 h
- Independent homework 71 h

MARKING (max 100 points)

- **Lecture Exercises 36 points:**
12 x 3 p (min. 18 p)
- **Learning Diary 64 points:**
12 x 5 p + 4 p (min. 32 p)
- **NO EXAM**

After the course the student:

1. has an overview of the variety of inorganic materials employed in advanced technologies
2. is able to discuss the most important physical properties of functional inorganic materials
3. is able to analyze the “basic chemistry” – “crystal structure” – “microstructure” – “physical property” relations in functional materials
4. is able to read and critically evaluate scientific papers on topics related to inorganic materials chemistry

The course provides/covers/focuses:

- insights into various important/new functional inorganic material families
- applications related to e.g. new sustainable energy technologies, conventional electronics, optics, spintronics & other emerging fields
- e.g. superconductive, magnetic, ferroelectric, thermoelectric, Li-ion and oxide-ion conductive & photoactive materials
- physical phenomena behind the targeted material functions

Functional Inorganic Materials

Fall 2023

Mondays: 10.15 - 12.00
Thursdays: 10.15 - 12.00

Lecture hall locations: U7 in Otakaari 1 / U-wing
Ke1 in Kemistintie 1 (CHEM building)

You can use <https://usefulaaltomap.fi/> to see the exact location of U7.

#	Date	Place	Who	Topic
1	Mon 4.9.	U7 (U135a)	Maarit	Introduction + Material design
2	Thu 7.9.	Ke1 (A305)	Antti	Introduction + Computational materials design
3	Mon 11.9.	U7 (U135a)	Maarit	Superconductivity: High- T_c superconducting Cu oxides
4	Thu 14.9.	Ke1 (A305)	Maarit	Magnetic oxides
5	Mon 18.9.	U7 (U135a)	Maarit	Ionic conductivity (Oxygen): Oxygen storage and SOFC
6	Thu 21.9.	Ke1 (A305)	Maarit	Ionic conductivity (Lithium): Li-ion battery
7	Mon 25.9.	U7 (U135a)	Antti	Thermal conductivity
8	Thu 28.9.	Ke1 (A305)	Antti	Thermoelectricity
9	Mon 2.10.	U7 (U135a)	Antti	Piezoelectricity
10	Thu 5.10.	Ke1 (A305)	Antti	Pyroelectricity and ferroelectricity
11	Mon 9.10.	U7 (U135a)	Antti	Luminescent and optically active materials
12	Thu 12.10.	Ke1 (A305)	Maarit	Hybrid materials

Typical framework of the lecture

- Phenomenon/Function & Applications (~20 min)
- Material requirements (e.g. chemistry & structure) (~20 min)
- Existing state-of-the-art materials (~30 min)
- Design of new materials (~30 min)

EXAMPLES OF FUNCTIONS/DEVICES

- High- T_c superconductors
- Thermoelectrics
- Optics
- Ferro-, pyro- and piezoelectrics
- Oxygen storage
- SOFCs
- Li-ion battery

RESEARCH GOALS

- Enhanced performance
- Better safety, cheaper price, environmental aspects
- Replacement of critical raw materials
- Discovery of new enabling materials

TYPES OF MATERIALS

- Metals and alloys
- Oxides and other ceramics
- Hybrids and composites

EXAMPLES OF IMPORTANT PHYSICAL PROPERTIES

- Electrical conductivity
- Ionic conductivity
- Thermal conductivity

CHEMICAL TOOLS FOR MATERIAL TAILORING

- Crystal structure (e.g. layered structure, high symmetry)
- Chemical substitutions: partial/complete; isovalent/aliovalent; chemical pressure/carrier doping
- Redox chemistry (e.g. oxygen content control)
- Nanostructuring
- Surface coating
- etc.

Lecture Exercises

- **You will get the exercise questions and also the detailed instructions before or during each lecture**
- **The questions/assignments may somewhat differ depending on the lecture subject and/or lecturer**
- **Important to remember:** you can earn more than one third of the course points with these lecture exercises!

Learning Diary (1/2)

- **Purpose of the learning diary**
 - Deepen **your understanding** of the subject
 - Urge you to develop **your learning process**
 - Help the teachers to improve the course
- **Structure of diary (for each individual lecture)**
 - State clearly whether you attended or not the lecture
 - Short summary of the lecture topic
 - Summarize shortly what did you know about the topic beforehand
 - What was the **most important new knowledge/understanding** you gained from the lecture
 - Did something remain unclear / Did you try to clarify afterwards
 - What kind of **additional information related to the topic** you got inspired to find (particularly important when you: (i) aim at the highest grade, (ii) did not attend the lecture)
- **Practicalities**
 - The whole diary in a single file & return it weekly in MyCourses
 - For each lecture 2-3 pages (some figures may be included); In total 20-30 pages
 - Write a last short summary chapter, where you reflect on the whole course (4 points):
 - * Did your interest in the course subjects change during the course
 - * Did your learning process change during the course
 - * What grade would you give for yourself
- **Important to remember:** your learning diary is the most important part of your course evaluation!

Learning Diary (2/2)

- **How detailed the diary should be?**
 - Write the diary at such level that your peers on the course would also understand the contents of the diary.
- **Using literature sources and avoiding plagiarism.**
 - We encourage you to use literature sources to deepen your understanding of the topics.
 - *All text in the diary must be written in your own words.* Directly copy-pasting text written by others is considered plagiarism (not allowed).
 - You may quote text from the literature, but you need to cite the source.
 - The final versions of the diary will be run through Turnitin originality check.
- **Rules on the use of artificial intelligence (AI) systems such as ChatGPT.**
 - Aalto University has published [guidelines for use of artificial intelligence in learning](#).
 - While writing your diary, you can use AI systems to learn more about the topics of the course.
 - *All text in the diary must be written in your own words.* Direct use of content generated by AI systems is forbidden.
 - You may quote text generated by AI system, but you need to cite the source.
 - The final versions of the diary will be run through Turnitin AI detection check.