Course Package

Fundamentals of Materials – Q3

Name module	Fundamentals of Materials – Q3
Course Code	202000618
Educational programme	BSc Advanced Technology
Period	First quartile of the second semester – Q3
Study load	15 ECTS
Coordinator	A.W. Schouwstra

Fundamentals of Materials			
Quartile 1	**Quartile 2**	**Quartile 3**	**Quartile 4**
		Structure and Properties of Materials **202400642** (3 EC)	
		Quantum Matter and Devices **202500299** (4 EC)	
		Properties of Polymer Materials **202500302** (3 EC)	
		Materials Project **202400643** (3 EC)	
		Diffraction Lab **202500303** (1 EC)	

Required preliminary knowledge: High school Physics; Calculus of Integrals; Integrals in Multiple Dimensions: including double and triple integrals; high school Math; Programming Skills, i.e. Matlab or Python.

202200188 - Structures and Properties of Materials

The 3 main classes of materials are discussed in this part of the module: metals, polymers, and inorganic materials such as ceramics and glass. The structure of these classes of materials are described on various length scales, going from atoms and atomic bonds, via microscopic, to macroscopic objects. The mechanical and electrical properties of materials are described and explained from the underlying structure on different length scales. This block ends with a discussion of metals and semiconductors.

202500299 - Quantum Matter and Devices

The basic elements of quantum mechanics will be introduced using a series of examples from modern physics. The following topics will be addressed: duality of particles, diffraction, photo-electric effect, uncertainty relation of Heisenberg, Schrödinger equation, quantum mechanical particle in a box, atoms and molecules, free electron model, band theory of solids, semiconductors and superconductors.

202500302 - Properties of Polymer Materials

202400643 - Materials Project

The modules are tentative and subject to change. Please check the website regularly.
Be aware that resits may occur outside of the block. This may mean you cannot partake in these without making additional travel arrangements.

This course consists of a project assignment and a lab assignment (practicum). To complete this course, you need to complete both assignments, and the same groups are used for both assignments. Students work in groups of 3, and you form these groups yourselves. This means that any student who is not a first-year AT student needs to report to the coordinator (Arnoud Onnink) 2 weeks in advance, so that we can help you join a group.

The lab assignment involves a puzzle: you get an unknown powder from the teachers (different groups get different powders) and measure the X-ray diffractogram. You analyse the data and conclude, on the basis of your data analysis which should meet scientific standards, which powder it is. You write a scientific report (research format) about this analysis. The lab assignment + report form 30% of the course grade.

For the project assignment (70% of the course grade), students run a fictional consultancy agency. The agency is asked to formulate an advice, based on the latest scientific literature, to a technology company (usually but not always fictional) about improving a material that is used in a device. The technology company is represented by a chief technology officer (CTO), usually in fact a staff member from the university who performs research on your topic. The exact assignment (material, device, questions) is specific for your group and formulated by the CTO. Some examples are: perovskite solar cells, quantum dots for quantum bits, lithium ion batteries with solid electrolytes, photonic crystals used in EUV optics or as solar cell back reflectors. The topic is always related to materials science and as such connected to at least one of the other courses in module 3 AT, but you will dive deeper into your specific topic than what is covered at the course lectures.

A key point of the project is that you learn how to master a topic by finding and studying literature, instead of getting ready-made lectures from teachers who have already done that for you.

The project has 2 phases. In both, you search and study the literature, and report your findings in multiple ways. Phase 1: study the basic principles of the device and materials. Formulate questions to research in phase 2. Culminates in an initial report and an interview with the CTO, which are not graded, but are essential to choosing a good path for phase 2. Phase 2: study state-of-the-art materials' research for the device. Formulate an advice to your customer. Culminates in the final report and pitch, which are assessed. The report provides the project assignment grade (70% of course grade), and the pitch is a pass/fail assignment that must be passed to complete the course.

You will get lectures about Searching for Information, and Working with Information by Hanneke Becht, who will also provide feedback in your search activities and intermediate reports. Arnoud Onnink organizes the course and gives 2 workshops: (1) Academic Writing, and (2) Pitching.

Students from outside AT:
please e-mail Arnoud Onnink at least 2 weeks in advance so that we can make sure that we have enough project assignments, and we can include you in the group formation process. Also beware that you need prior knowledge on the analysis of X-ray diffraction data, or you need to be willing to learn this during the course (for example by following the course “Structure and properties of materials” in AT module 3.)

202500303 - Diffraction Lab

This lab assignment involves a puzzle: you get an unknown powder from the teachers (different groups get different powders) and measure the X-ray diffractogram. You analyse the data and conclude, on the basis of your data analysis which should meet scientific standards, which powder it is. You write a scientific report (research format) about this analysis. The grade is formed by your lab journal and report.

This course is intended for students who are also taking Structure and Properties of Materials, and the project of the 2nd semester AT. The reason is that we use the same groups and concepts taught in the theory course. If you do not meet these criteria, contact Arnoud Onnink at least 2 weeks in advance of the course.

Students from outside AT:

please e-mail Arnoud Onnink at least 2 weeks in advance so that we can make sure that we have enough capacity

and so we can include you in the group formation process. Also beware that you need prior knowledge on the analysis of X-ray diffraction data, or you need to be willing to learn this during the course (for example by following the course “Structure and properties of materials” in AT module 3.) This course involves a visit to a research laboratory with high-end XRD equipment, which can only be done at a specific moment and with limited capacity. Thus, if you do not contact me in advance as required, there is a high chance I will have no way of arranging a spot for you.

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