Course Package

Materials Science and Engineering

Name module	Materials Science and Engineering
Educational programme	BSc Advanced Technology
Period	Second quartile of the first semester (Quarter 1B)
Study load	15 ECTS
Coordinator	E.M. Marsman

Materials Science and Engineering			
Quarter 1A	**Quarter 1B**	**Quarter 2A**	**Quarter 2B**
	Advanced Materials (5 EC)		
	Chemistry and Technology of Inorganic Materials (5 EC)		
	Elective 1/2: **Semiconductor Devices** (5EC) **Physical Chemistry of Interfaces** (5EC)		

Required preliminary knowledge: Basic Quantum Mechanics, Basic Materials Science.

In any device whether this is an electronic transistor, solid-state battery or a gas sensor, several properties of different materials are combined to achieve a desired functionality. The objective of the module Materials Science and Engineering is to get the student acquainted with the relation between basic properties of materials and their functional application. This includes obtaining knowledge of the direct connection between material properties, structure/composition and material synthesis. At the end of the course, the student should be able to describe the functional properties of materials used in a specific device and be able to connect these to basic material properties in relation to the ability to synthesize these materials. The module consists of a general part in which first the relation between the functional properties of materials and the microstructure is discussed; subsequently the relation between the microstructure and specific synthesis techniques is studied. The second part is an elective part of either a chemistry track course that focuses on the effects of interfaces in materials with emphasis on catalytic reactions, or a physics track course that focuses on charge transport in semiconductor devices.

Advanced Materials

The modules are tentative and subject to change. Please check the website regularly.

The course Advanced Materials deals with the relation between material properties and structure/ composition. The course provides knowledge and insight into the functional properties of various material classes; and it provides understanding of the relations between microstructure and properties of materials. The course consists of lectures on the structure and functional properties of several material classes (polymer, ceramic and metal). In the lectures theory as well as practical cases are discussed. Furthermore, groups of 3 students will study a specific, technologically relevant material system, which will be presented to the other students.

Chemistry and Technology of Inorganic Materials
The course Chemistry and technology of inorganic materials deals with the relation between material synthesis and structure/composition. It will focus on the effect of specific synthesis techniques on the achieved microstructure, which determines the material properties, and therefore, can determines specific functionalities in materials. The course consists of lectures on the relation between microstructure and applied synthesis techniques (thin film, thick film, bulk) of inorganic materials. Various physical vapour deposition techniques as well as chemical vapour techniques for films will be discussed as well as sol gel and sintering techniques for obtaining bulk materials. The effect of strain in materials, caused by epitaxial growth, will also be studied. Furthermore, groups of 3 students will study a specific, technologically relevant material system, which will be presented to the other students.

Semiconductor Devices (choice)
Microelectronics strongly affects our daily life. The amount of integrated microelectronic circuits (ICs) rises drastically in many applications such as automotive, telecommunication, health care, portable computing and internet (ICT). In addition there is a continuous trend in increasing the complexity of the basic electronics building block, the microchip, realized in advanced CMOS (complementary metal-oxide semiconductor) technology, partly driven by the desire for increasing functionality. The microchip is formed by several key components, basically semiconductor devices. This course describes the physical working of these basic semiconductor devices and translates those to electrical characteristics.It covers an introduction to the classical electron devices: the pn-junction and the Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET). The physical working is illustrated using diagrams of energy, electric field, electrical potential and concentration, and the principal formulae for the simplified devices are treated. After the lectures and tutorials the students should understand the limits of the electrical performance of classical devices and should perform a literature survey on how to tackle these. Finally, they should write a 5-10 pages report about their findings.

Physical Chemistry of Interfaces (choice)
Physical Chemistry of Interfaces is a broad introduction in interfacial science, with a special emphasis on catalysis. Interfaces are everywhere in our daily life and interface effects are in many cases crucial (for instance in the functioning of the lungs). Interfaces become increasingly important when we reduce the dimensions. The behaviour of nanoparticles is for instance, mostly determined by their interfaces. We'll explain the relationship between catalysis and nanotechnology in this course. We'll start the course with an introduction in (chemical) kinetics: the mathematical description of (the speed) of (chemical) reactions. We also explain some chemical reaction mechanisms. Subsequently we study the physical and chemical properties of different interfaces (solid-gas, solid-liquid, gas-liquid), with special attention for topics like the wetting properties of surfaces (contact angle), stability of colloidal systems (like emulsions and foams). This knowledge is then applied on catalytic reactions, where we study adsorption and desorption of reactants and products, catalytic mechanisms, transport of the reactants/products and the identification of the catalytic mechanisms/materials in detail.