UCLouvain

lfyki1201

2026

Materials science

5.00 credits	30.0 h + 30.0 h	Q1

Teacher(s)	Charlier Jean-Christophe ;Jacques Pascal ;
Language :	French
Place of the course	Louvain-la-Neuve
Prerequisites	This course assumes knowledge of: - Classical wave physics and the basic concepts of quantum physics, as taught in the course **LEPL1203** (or equivalent course). - The basic concepts of atomistics, chemistry, physical chemistry, the structure of matter, and thermodynamics as covered in the courses **LEPL1301** and **LEPL1302** (or equivalent courses). - The concepts of statistical physics, basic quantum physics, and solid-state physics as taught in the course **LFYKI1102** (Statistical Physics and Solid-State Physics I) or equivalent course.
Main themes	This course aims to provide an introduction to materials science as a science that seeks to link the implementation, the microstructure, the atomic structure, and the properties of materials based on the fundamental principles of chemistry, physical chemistry, thermodynamics, quantum physics, and solid-state physics.
Learning outcomes	**At the end of this learning unit, the student is able to :** **Contribution of the course to the program's learning outcomes** With regard to the learning outcomes of the « Bachelor of Engineering Sciences within the Civil Engineering program », this course contributes to the development and acquisition of the following learning outcomes: Axis No. 1: knowledge of fundamental and polytechnic sciences: 1.1, .2 **Learning outcomes specific to the course** At the end of this course, students will be able to: • situate materials science in its broad context as a discipline useful in most engineering technologies; • know, define, and correctly use the vocabulary and notation specific to the discipline (e.g., ability to define terms such as lattice, atom, molecule, phase, eutectic, electron, phonon, tacticity, grain, precipitate, dislocation, conformation, stress, strain, modulus, stiffness, strength, electrical and thermal conductivities, thermoelectricity, magnetization, polarization, optical reflectivity and transmissivity, ...); • describe in text and diagram form the chemical bonds underlying the different classes of materials, amorphous or crystalline structures, crystal defects, the molecular architectures and microstructures they generate, and the physicochemical/thermodynamic mechanisms responsible for the formation of microstructures; • apply the basic concepts of crystallography, thermodynamics, and phase diagrams to solve simple exercises; • explain in writing and schematically the links between the structure of materials (atomic, molecular, microstructure) and their functional properties (electrical and thermal conductivity, optical, dielectric, magnetic properties, ...) and structural properties (enthalpic and entropic elasticity, glass transition, strength, ductility, ...); • master the notations (+ units), time, space, and temperature scales, and orders of magnitude involved in schematically representing the changes in the structural and functional properties of different classes of materials. • deduce, from the properties, the main areas of application of the classes of materials based on a global vision of materials science that transcends classes, but also explains the specific behaviors observed.
Evaluation methods	Students are assessed individually (written exam during the exam period) on the basis of the specific objectives announced in advance (questions testing their knowledge, understanding, and ability to apply the concepts covered during lectures, labs, and exercises).
Teaching methods	Lectures and practical sessions (exercises and labs) are held in parallel to enable students to apply the theoretical concepts presented in a more concrete way. Although the course contains a number of descriptive aspects, emphasis is placed on a good understanding of the concepts covered in the lectures in order to solve exercises or basic applications. Lectures will preferably be taught in person.
Content	This course is designed to introduce students to the basic concepts of materials science in three areas: synthesis/development of materials, description of atomic structure and microstructure, and functional and structural properties. The focus is primarily on the phenomena that dictate the formation of microstructures, the description of crystalline and amorphous structures and defects, and the basics of functional and structural properties. The objective is to provide the necessary foundations for students who will continue in the field of materials science, but also the most useful concepts for students who will then move on to other areas of engineering science and who will encounter questions about the use/choice of materials. **General introduction**

	Part I - Structure of materials and genesis of microstructures 1.1 Review of bonding and states of matter 1.2 Thermodynamics of mixtures, interfaces, diffusion, nucleation, growth 1.3 Phase diagrams 1.4 Crystalline materials (review of the basics of crystallography, crystal defects, microstructures) 1.5 Amorphous materials (including, among other things, the main polymerization reactions, tacticity and molecular architecture - amorphous solids, polymorphism, brief introduction to amorphous inorganic solids) Sections 1.1, 1.2 & 1.3 are covered across all material classes. **Part II - Functional properties of materials** 2.1 Review of quantum concepts: electrons and phonons 2.2 Electrical conductivity in metals and semiconductors (+ laboratory session on electrical measurements) 2.3 Concept of superconductivity (BCS theory) 2.4 Electronic thermal conductivity in metals (Wiedmann Franz law) 2.5 Thermal conductivity of electrical insulators 2.6 Concepts of thermoelectricity 2.7 Properties of dielectric materials (concepts of polarization) 2.8 Properties of magnetic materials (concepts of magnetization/spin) 2.9 Optical properties of materials (concepts of reflection, transmission, propagation, refraction, absorption, diffusion, luminescence, fluorescence, phosphorescence, etc.) **Part III - Thermomechanical properties of materials** 3.1 Mechanical behavior from a macroscopic perspective (+ exercise session and laboratory) 3.2 Relationships between molecular architecture, microstructure, and structural properties of polymer materials 3.3 Relationships between defects, microstructure, and structural properties of metallic and ceramic materials
Bibliography	Plusieurs livres d'introduction à la science des matériaux sont disponibles en bibliothèque.
Faculty or entity in charge	FYKI

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Minor in Applied Chemistry and Physics	MINOFYKI	5		
Master [120] in Biomedical Engineering	GBIO2M	5		
Specialization track in Applied Chemistry and Physics	FILFYKI	5		
Mineure Polytechnique	MINPOLY	5		