Corso di Laurea in
SCIENZA E TECNOLOGIA DEI MATERIALI

Triennale – L30

General information		
Academic subject	***Material chemistry***	
Degree course	*CISTeM*	
Academic Year	*2021-2022*	
European Credit Transfer and Accumulation System (ECTS)		6
Language	*italian*	
Academic calendar (starting and ending date)	*To be defined, will be posted on the web*	
Attendance	*Yes*	

Professor/ Lecturer	
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Virtual headquarters	*Windows teams*
Tutoring (time and day)	Email appointment

Syllabus	
Learning Objectives	The course aims at providing a solid basic training in Solid State Chemistry in the field of Materials Science and Technology. The aim of the course is to complete the scientific training of students with basic knowledge on the structure and properties of solid-phase systems. Particular attention is placed to advanced materials for energy applications.
Course prerequisites	Basic concepts provided by General and Inorganic Chemistry. In particular: the chemical bond, periodic properties, electronic configurations. Basic principles of thermodynamics. Basic knowledge of mathematics and physics.
Contents	Introduction to materials Definition and historical perspectives. Classification of materials. Advanced materials, the example of biomaterials and of the materials for the energy conversion. Descriptive crystal chemistry. Classification of solids based on the type of chemical bond. Structure of crystalline solids Crystal systems and Bravais lattices. Main metallic crystalline structures. Planes and directions in the crystals. Polymorphism and allotropy. Imperfections in solids Solid metallic solutions. Crystalline defects. State diagrams Gibbs phase rule. Isomorphic binary alloys. Eutectic binary alloys. Metallic materials Introduction. Iron-carbon state diagram. Ceramic materials Introduction. Crystalline structures. Structure of perovskite (CaTiO3). Carbon and its allotropic forms. Nanostructured materials Introduction. Production techniques: top-down and bottom-up approach. Applications in the energy sector. Biomaterials

	Introduction to biomaterials. Properties of materials Outline of the optical properties of materials. Outline of the electrical properties of materials. [Exercise in groups In-depth study of a class of materials with specific application purposes] Energy materials The energy challenges. Renewable energies. Third generation solar cells. Chlorophyll photosynthesis. Mimic nature: the example of dye solar cells (DSSC with laboratory experience). An innovative material in the energy field: the example of hybrid halide perovskites. Targeted use of the concepts introduced in the course for the in-depth study of the structure-property relationship in halide hybrid perovskites. [Laboratory experience Assembly and characterization of a natural organic dye cell (DSSC)]
Books and bibliography	Materials Science and Technology, Smith & Hashemi, Graw Hill. Lecture notes by the teacher (biomaterials and energy materials)
Additional materials	Only a few chapters and in these only some sections

Work schedule			
Total	Lectures	Hands on (Laboratory, working groups, seminars, field trips)	Out-of-class study hours/ Self-study hours
Hours			
150	40	15	95
ECTS			
6	5	1	

Teaching strategy	
	Lectures with slides, in-depth videos of the topics covered, group and individual work pre-, during and post-laboratory.
Expected learning outcomes	
Knowledge and understanding on:	• Knowledge and understanding • knowledge of the main classes of materials, understanding of the fundamental differences between them. Knowledge of the role played by materials, dependent on their basic properties, in different technological contexts, and in the development of third generation solar cells.
Applying knowledge and understanding on:	• Ability to learn and transfer basic knowledge on the characteristics and properties of materials. Ability to learn and transfer simple experimental procedures.
Soft skills	• Autonomy of judgment • Knowing how to evaluate the potential use of a material based on its properties. • Communication skills • Skills in communication in the Italian language • ability to express oneself in the presentation and dissemination of one's knowledge with appropriate scientific language • ability to work in a team.

Assessment and feedback	
Methods of assessment	Verification of the student's ability to profitably participate in a laboratory experience ° Verification of the student's ability to work in a group for the preparation of a presentation aimed at discussing the possible technological applications of a chosen class of materials ° Final exam (oral)
Evaluation criteria	• Knowledge and understanding Minimum level for passing the exam: knowledge of the various classes of materials and the main differences between them. Intermediate level: knowledge of the different properties of the materials discussed in the course, knowledge of the functionalities deriving from the different structures / preparation methods. Upper level: In-depth knowledge of the properties of the materials discussed in the course with a critical approach to the problems posed. Ability to trace links between the different teaching modules. • Applied knowledge and understanding Minimum level for passing the exam: recognition of the various types of materials introduced in the course in technological contexts. Intermediate level: knowledge and discussion of the properties characterizing the various materials with specific reference to the contexts of application of the same. Higher level: in-depth knowledge and critical approach to material requirements in various applications, including discussion of open issues. Ability to relate the basic properties of materials to their use in technology, with reference to the conversion of light energy • Autonomy of judgment For intermediate and higher levels: Evaluate, with an independent approach, the advantages, and limitations of the use of different materials in applicative contexts. • Communication skills For all levels: demonstrate the knowledge of the correct scientific terminology, relating to the knowledge required for the three levels, and explain the topics of the exam questions with appropriate language. • Ability to learn In carrying out the exam, the topics proposed will have an increasing degree of depth to establish what level of knowledge, fundamental, intermediate, or higher, the student's learning ability has reached.
Criteria for assessment and attribution of the final mark	The final grade will be awarded through the composition of the partial judgments resulting from participation to the laboratory experience, from the group exercise and from the oral exam.
Additional information	