



Subject card

Subject name and code		Functional Materials , PG_00063140						
Field of study		Materials Engineering						
Date of commencement of studies		October 2024	Academic year of realisation of subject			2024/2025		
Education level		first-cycle studies	Subject group			Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study		Full-time studies	Mode of delivery			at the university		
Year of study		1	Language of instruction			Polish		
Semester of study		2	ECTS credits			4.0		
Learning profile		general academic profile	Assessment form			exam		
Conducting unit		Institute of Nanotechnology and Materials Engineering -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)		Subject supervisor		prof. dr hab. inż. Maria Gazda				
		Teachers		prof. dr hab. inż. Maria Gazda Daniel Jaworski				
Lesson types and methods of instruction		Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
		Number of study hours	30.0	0.0	15.0	0.0	0.0	45
		E-learning hours included: 0.0						
Learning activity and number of study hours		Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours		Self-study	SUM	
		Number of study hours	45	5.0		50.0	100	
Subject objectives		Understanding functional materials due to their thermal, electrical and optical properties						
Learning outcomes		Course outcome	Subject outcome			Method of verification		
		[K6_W03] Has knowledge of materials science and can relate the properties of materials with their structure and composition, knows the theoretical description of phenomena occurring in materials subjected to external factors.	Has basic knowledge of functional materials and is able to relate thermal, electrical and optical properties to their composition and structure, knows the description of phenomena occurring under the influence of electric field and temperature.			[SW1] Assessment of factual knowledge		
		[K6_U03] Can critically analyze and evaluate the functioning – particularly in the context of materials engineering –existing technical solutions, particularly equipment, objects, systems, processes.	Can critically analyze the operation of, for example, a thermistor, thermoelectric cell, Bragg mirror, etc.			[SU2] Assessment of ability to analyse information		
		[K6_U07] Can obtain information from literature and other properly selected sources, also in English or other foreign language used for international communication in materials engineering.	Can find the latest information on functional materials in international databases, especially literature ones.			[SU4] Assessment of ability to use methods and tools		
		[K6_U09] Has the ability to prepare oral presentations in Polish and in a foreign language, concerning detailed issues, using fundamental theoretical approaches, and diverse sources.	Able to prepare and deliver a 15-20 minute oral presentation on the latest functional materials			[SU1] Assessment of task fulfilment		

Subject contents	Lecture: Introductory knowledge: functional and structural materials, basic knowledge about the structure of materials. Division of materials in terms of chemical bonds: the relationship of chemical bonds with structure, structural defects and properties. Functional materials due to their thermal properties: introductory knowledge, i.e. specific heat, thermal expansion and thermal conductivity; phase changes; selected materials with high/low heat capacity; selected materials with high/low/zero thermal expansion; selected insulating/thermally conductive materials; phase change materials and their applications. Functional materials due to their electrical properties: introductory knowledge, i.e. conductivity and specific resistivity of the material, mechanisms of electrical conductivity, ionic conductivity, dependence of electrical conductivity on temperature and other factors; superconductivity; electrical properties of dielectrics. Selected conducting/superconducting/semiconducting/dielectric materials and their applications. Functional materials due to their optical properties: introductory information, i.e. refractive index, reflection and absorption and their relationship to the chemical composition and structure of the material; dependence of optical properties on wavelength for selected materials. Selected reflective/antireflective, birefringent, transparent/opaque materials and their applications. Smart materials: thermo/photo/electrochromic. Examples of methods for manufacturing and shaping functional materials: layering, texturing materials, introducing deformation, manufacturing nanomaterials, Summary: examples of applications in which more than one group of properties of functional materials is used. Laboratories: development of manufacturing method, manufacturing of a functional ceramic sample, investigation of its phase composition, investigation of its microstructure, investigation of functional properties, analysis and discussion of results.		
Prerequisites and co-requisites	no		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	lab assesment	52.0%	30.0%
	written exam	52.0%	70.0%
Recommended reading	Basic literature	any textbook on materials science	
	Supplementary literature	scientific literature	
	eResources addresses	Adresy na platformie eNauczenie: Materiały funkcjonalne - Moodle ID: 27783 <a href="https://enauczenie.pg.edu.pl/moodle/course/view.php?id=27783">https://enauczenie.pg.edu.pl/moodle/course/view.php?id=27783</a>	
Example issues/ example questions/ tasks being completed	1. Mark the true statements (there may be more than 1). a. the rate of diffusion is the highest in materials with a high density of atomic packing in the structure; b. the rate of diffusion increases with increasing temperature; c. the rate of diffusion is proportional to temperature; d. the rate of diffusion depends on temperature and on the type and concentration of structural defects; e. diffusion in the solid state can cause damage to some materials or devices. 2. Many of the "functional materials" discussed in the lectures were oxides. Name three of them, describe one (in relation to the topics discussed in class). 3. Name the conductors of oxygen/sodium/... ions, describe one. 4. What does the rate of reaction in the solid state depend on (and how)? 5. How can the rate of reaction in the solid state be increased? 6. Propose a material from which heating elements can be made for a furnace operating in an oxygen atmosphere at a temperature of 1000 C. 7. Propose materials that must be used to make a resistor/electrical connections on a printed circuit board/cables for underwater/air/underground installations/. 8. What properties should a dielectric have in a capacitor? Propose an example material.		
Work placement	Not applicable		

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