



Subject card

Subject name and code	Functional Materials , PG_00063140						
Field of study	Materials Engineering						
Date of commencement of studies	October 2026	Academic year of realisation of subject			2026/2027		
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 -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Maria Gazda				
	Teachers		prof. dr hab. inż. Maria Gazda				
Lesson types	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_U03] is able to critically analyse the operation, risks, economic efficiency, and usefulness, and to critically evaluate existing technical solutions—especially in relation to materials engineering—taking into account non-technical factors, including ethical aspects		Can critically analyze the operation of, for example, a thermistor, thermoelectric cell, Bragg mirror, etc.		[SU2] Assessment of ability to analyse information		
	[K6_U07] is able to learn independently throughout life by obtaining information from literature, databases, and other appropriately selected sources, including in English or another foreign language recognised as an international language of 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_W03] has knowledge of materials science that enables one to relate the properties of materials to their structure and composition; is familiar with the theoretical description of phenomena occurring in materials subjected to external factors and understands the processes taking place throughout their life cycle		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		

Subject contents	<p>Course content – lecture</p> <p>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.</p>											
Prerequisites and co-requisites	no											
Assessment methods and criteria	<table border="1"> <thead> <tr> <th>Subject passing criteria</th> <th>Passing threshold</th> <th>Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>lab assesment</td> <td>52.0%</td> <td>30.0%</td> </tr> <tr> <td>written exam</td> <td>52.0%</td> <td>70.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	lab assesment	52.0%	30.0%	written exam	52.0%	70.0%
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Recommended reading	<table border="1"> <tbody> <tr> <td>Basic literature</td> <td colspan="2">any textbook on materials science</td> </tr> <tr> <td>Supplementary literature</td> <td colspan="2">scientific literature</td> </tr> <tr> <td>eResources addresses</td> <td colspan="2"></td> </tr> </tbody> </table>			Basic literature	any textbook on materials science		Supplementary literature	scientific literature		eResources addresses		
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Example issues/ example questions/ tasks being completed	<p>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.</p> <p>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).</p> <p>3. Name the conductors of oxygen/sodium/... ions, describe one.</p> <p>4. What does the rate of reaction in the solid state depend on (and how)?</p> <p>5. How can the rate of reaction in the solid state be increased?</p> <p>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.</p> <p>7. Propose materials that must be used to make a resistor/electrical connections on a printed circuit board/cables for underwater/air/underground installations/.</p> <p>8. What properties should a dielectric have in a capacitor? Propose an example material.</p>											
Practical activities within the subject	Not applicable											

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