GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Physical chemistry of solids, PG_00063525		
Field of study	Materials Engineering		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2025/2026
Education level	second-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	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division Of Ceramics -> Institute Of Nanotechnology And Materials Engineering -> Faculty Of Applied Physics And Mathematics -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Aleksandra Mielewczyk-Gryń	
	Teachers	dr hab. inż. Aleksandra Mielewczyk-Gryń	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	0.0	30
	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	30	3.0	17.0	50

Subject objectives	Solid-state physical chemistry is a field of science that studies the physical and chemical properties of substances in the solid state, focusing on the interactions between their atoms and molecules. It involves the analysis of the structure, optical, magnetic, electrical, thermal, and mechanical properties of materials. In energy, solid-state physical chemistry plays a key role, especially in the context of materials used in power plants, energy storage, fuel cells, and batteries. Understanding processes such as electrical conductivity, thermal conductivity, and material reactivity enables the development of new, more efficient, and durable energy technologies.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_K01] Understands the need for lifelong learning, can inspire and organize the learning process of others. Is aware of own limitations and knows when to turn to experts, can accurately determine priorities helping to achieve the tasks specified by themselves or others.	undestands the need to learn whole his/her life	[SK4] Assessment of communication skills, including language correctness [SK2] Assessment of progress of work
	[K7_U02] Can independently determine the directions of self-development and implement the self-education process it in order to raise professional competences.	knows what direction he/she wants to work in the future	[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
	[K7_W01] Has extended knowledge of the fields of science and scientific disciplines relevant to materials engineering, and their historical development and importance for the progress of exact and natural sciences, knowledge of the world and evolution of humanity.	has extended knowledge on physics of materials	[SW1] Assessment of factual knowledge
	[K7_W05] Knows methods, techniques, tools and materials for solving complex engineering tasks relevant to materials engineering.	know all of the basic methods of solid state physics and chemistry	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects

Subject contents	**Introduction** Solid-state physical chemistry is an interdisciplinary field that combines elements of physics, chemistry, and materials science, studying the properties of substances in the solid state. It addresses both the structure of materials and their interactions at the atomic and molecular levels, which is crucial for understanding their behavior under different conditions. **Atomic vibrations, thermal properties** Atomic vibrations in the crystal lattice of a material are fundamental to its thermal properties. These vibrations generate thermal waves that affect thermal conductivity. Studying these vibrations helps understand how materials respond to temperature changes, the mechanisms of heat conduction, and the effects of defects and impurities in the structure on thermal properties. **Chemistry of defects** Defects in solids are deviations from the ideal material structure, such as vacancies, interstitials, or dislocations. The chemistry of defects studies the impact of these imperfections on material properties, including stability, electrical and thermal conductivity, and chemical reactions. Defects can also influence the optical and magnetic properties of substances. **Electronic properties: approximations, energy bands, electrical properties** The electronic properties of materials in the solid state are crucial for their electrical and magnetic behavior. Theoretical approximations, such as the free electron model, and the concept of energy bands (e.g., valence band, conduction band) help explain why a material may conduct electricity (conductors, semiconductors) or act as an insulator. Electrical properties are strongly dependent on the band structure and the presence of defects in the material. **Semiconductors and semiconductor junctions** Semiconductors are materials whose electrical conductivity can be modified by doping. Semiconductor junctions, such as p-n junctions, are fundamental in electronic technology, including transistors, diodes, and solar cells. Phenomena such as conduction, electron-hole recombination, and the impact of temperature on semiconductor properties are the basis of modern electronic devices. **Transport phenomena** Transport phenomena in solid materials include electrical, thermal, mass, and optical conductivity. Particularly important is the study of how electrons, ions, or photons move through the material in response to external stimuli (e.g., electric fields, temperature gradients). These phenomena are crucial in designing materials for energy and electronic devices. **Superconductivity** Superconductivity is a phenomenon in which a material, under certain temperature conditions (below the so-called critical temperature), becomes an excellent conductor of electricity, eliminating electrical resistance. This is a quantum effect related to the pairing of electrons into Cooper pairs. Superconductivity is used in technologies such as magnets, MRI devices, and the development of energy technologies, such as transmission networks. **Dielectric and optical properties** Dielectric materials have the ability to store electric charge under the influence of an electric field. These properties are important in capacitors, memory devices, and touchscreens. On the other hand, the optical properties of materials are related to their ability to absorb, reflect, transmit, or emit light, which is key in optoelectronic applications, such as LEDs, lasers, and photodetectors. Studying light-matter interactions also enables the development of new photonics materials. **Elements of scientific language** based on the analysis of publications related to the lecture topic. **Current trends** in solid-state physicochemistry in the context of recent research. Challenges for energy materials and the role of fundamental research in the development of new energy technologies.
Prerequisites and co-requisites	
Assessment methods and criteria	see table below

Subject passing criteria	Passing threshold	Percentage of the final grade
the possibility of improving the grade by participating in gamification elements	0.0%	0.0%
midterm/final test	50.0%	100.0%

<table>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>1. Ch. Kittel "Introduction to solid state physics"
2. W. Ashcroft , N. D. Mermin "Solid state physics"</td></tr>
<tr><td>Supplementary literature</td><td>H Ibach, H. Lüth - Solid State Physics</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/
example questions/
tasks being completed</td><td colspan="2">- Describe heat capacity in metals

- Whats the difference between supercapacitor and ideal capacitor?

- GIve the expression for Fermi energy at 0K</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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