



## Subject card

Subject name and code	Solid state physicochemistry, PG_00052984						
Field of study	Chemistry in Construction Engineering						
Date of commencement of studies	February 2023		Academic year of realisation of subject		2022/2023		
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	1		ECTS credits		6.0		
Learning profile	general academic profile		Assessment form		exam		
Conducting unit	Department of Inorganic Chemistry -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Jarosław Chojnacki				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	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	60		20.0		70.0	150
Subject objectives	Student gets knowledge on physical chemistry of solids						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K7_W01	has wide and deep knowledge in scope of mathematics, physics, chemistry and crystallography used for description of materials used in contemporary construction industry			[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge		
	K7_U07	can choose appropriate research method for determination of desired properties of materials. Knows strong and weak sides of the methods			[SU5] Assessment of ability to present the results of task		
	K7_W06	student has solid and deep knowledge on advanced methods for determination of structure and physical properties of materials			[SW1] Assessment of factual knowledge		
K7_W03	has wide and deep knowledge in scope of solid state chemistry, structure and bonding in solids, interpretation of phenomena characteristic for solids, in particular about properties of new materials applied in contemporary technology			[SW1] Assessment of factual knowledge			

Subject contents	<p>General description of solids and their structure. Thermodynamic function for crystalline solids, lattice energy, Born-Haber cycle. Vibrations in crystals: Einstein model and Debye's model of lattice vibrations, phonons. Outline of band model of electronic structure of solids. First Brillouin zone, direct and indirect band gaps.</p> <p>Imperfections of solids. Dislocations, point defects. Equilibrium concentration of intrinsic defects. Solid solutions, modulated structures, superstructures. Chemical compounds with non-integral coefficients. Kroeger and Vink symbols for defects. Brouwer diagrams.</p> <p>Transport of atoms. Fick's laws, Kirkendall phenomenon. Basic calculations of diffusion, Boltzmann-Matano method for determination of diffusion coefficients in binary systems. Conductivity of solids, solid electrolytes. One- and two-dimensional solids, synthetic metals, intercalation of graphite and TiS<sub>2</sub>. Thermochromism and electrochromism. Magnetic properties of solids, Curie-Weiss law. Piezoelectric, ferroelastic and pyroelectric effects. Hydrophobic and Hydrophilic effects, the contact angle and wettability of a surface. Preparative methods in solid state chemistry: sol-gel, microwave, high-pressure, applying precursors.</p> <p>Rate of solid state reactions, morphology of products. Influence of structural defects on rate of reaction. The role of interfacial surface in reaction kinetics. Basics of crystal growth theory.</p>											
Prerequisites and co-requisites												
Assessment methods and criteria	<table border="1" data-bbox="448 725 1487 824"> <thead> <tr> <th data-bbox="448 725 794 757">Subject passing criteria</th> <th data-bbox="794 725 1141 757">Passing threshold</th> <th data-bbox="1141 725 1487 757">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="448 757 794 788">Colloquia + presentation</td> <td data-bbox="794 757 1141 788">60.0%</td> <td data-bbox="1141 757 1487 788">50.0%</td> </tr> <tr> <td data-bbox="448 788 794 824">Written exam</td> <td data-bbox="794 788 1141 824">51.0%</td> <td data-bbox="1141 788 1487 824">50.0%</td> </tr> </tbody> </table>			Subject passing criteria	Passing threshold	Percentage of the final grade	Colloquia + presentation	60.0%	50.0%	Written exam	51.0%	50.0%
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Written exam	51.0%	50.0%										
Recommended reading	Basic literature	<p>L. Smart and E. Moore, <i>Solid State Chemistry</i>, Taylor &amp; Francis Group, 2005</p> <p>H. Kittel, <i>Wstęp do Fizyki Ciała Stałego</i>, Wyd. Naukowe PWN, 2012</p> <p>H. Schmalzried, <i>Reakcje w ciele stałym</i>, PWN 1978 lub wydania późniejsze</p>										
	Supplementary literature	<p>H. Mehrer, <i>Diffusion in Solids: Fundamentals, Method, Materials, Diffusion-Controlled Processes</i>, Springer-Verlag, Berlin Heidelberg, 2007</p> <p>J. Dereń, J. Haber, R. Pampuch, <i>Chemia ciała stałego</i>, PWN, Warszawa 1975.</p> <p>N.B. Hannay, <i>Chemia Ciała Stałego</i>, PWN Warszawa 1972</p>										
	eResources addresses	Adresy na platformie eNauczanie:										
Example issues/ example questions/ tasks being completed	<ol style="list-style-type: none"> <li>1. Explain why ionic conductivity of pure KCl is smaller than KCl doped with SrCl<sub>2</sub>. Draw schematically relation <math>\log(\sigma) = f(1/T)</math> for both materials.</li> <li>2. During diffusion experiment, in semi-infinite system of copper and brass, neutral markers (tungsten wires) placed between the phases drift towards brass. What do we call this phenomenon? Which partial diffusion coefficient is higher (<math>D_{Zn}</math> or <math>D_{Cu}</math>)? Is this an example of interstitial diffusion or vacancy diffusion mechanism?</li> <li>3. Determination of diffusion coefficient <math>D(c)</math> by the Boltzmann-Matano method.</li> </ol>											
Work placement	Not applicable											