GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Ionic conductivity in Crystals, PG_00049536		
Field of study	Materials Engineering, Materials Engineering, Materials Engineering		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2023/2024
Education level	second-cycle studies	Subject group	Optional subject group 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	2	Language of instruction	Polish polish or english
Semester of study	3	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Zakład ceramiki -> Instytut Nanotechnologii i Inżynierii Materiałowej -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Sebastian Wachowski	
	Teachers	dr inż. Sebastian Wachowski	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	20.0	0.0	0.0	10.0	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	0.0	0.0	30

Subject objectives

The subject aims to deepen and systematize students' knowledge of electrical conduction in solids. The content presented concerns both transport theory and measurement techniques used in practice.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K7_K01	The student understands the constant need for self-development which is predicated by continuous changes of science, especially solid-state ionics. Student knows where to look for new knowledge and understands the role of mentor in selfdevelopment.	[SK5] Assessment of ability to solve problems that arise in practice
K7_U02	Student has a task (project) that uses the knowledge gained during the lecture as a starting point for selfdevelopment.	[SU1] Assessment of task fulfilment
K7_U01	Student can combine the knowledge gained during the lecture with literature data to analyse a model material.	[SU3] Assessment of ability to use knowledge gained from the subject
K7_W05	The student learns advanced methods of defect chemistry, thermodynamics and modeling to analyze changes in defect settings in crystals. On this basis, a change in material properties due to changes or changes in external factors can be applied	[SW1] Assessment of factual knowledge

Subject contents	Lecture:Introduction to the subject. Reminder of basic concepts from crystallography and materials physics. (2 hours)Point defects in crystals: defect formation, Kroger-Vink notation, defect reaction equations, law of mass action for defects, Brouwer diagrams. (6 hours)Doping (2 hours)Diffusion phenomena in crystals: basic concepts, diffusion mechanisms, spontaneous, tracer and chemical diffusion coefficients, Fick's first and second law (5 hours)Mobility of charge carriers and introduction to electrical conductivity: definitions and relationships, Nernst-Einstein equation (4 hours)Additional tasks on the presented issues will be available for students to solve on their own on the eNauczanie PG portal. Knowledge of the theoretical foundations, advanced issues related to electrical conductivity in crystals and the principles of operation of electrochemical devices used in industry will significantly facilitate the preparation of a master's thesis and the student's finding on the labor market.The project will involve calculating the Brouwer diagram for the selected material.
Prerequisites and co-requisites	Basic knowledge of crystallography, inorganic chemistry and materials physics

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written exam	50.0%	70.0%
Project assesment	50.0%	30.0%

Recommended reading

Basic literature

Literatura:

1.
C. Kittel, Wstęp do fizyki ciała stałego, Warszawa, PWN, 1999

2.
W. Bogusz, F. Krok, Elektrolity stałe, właściwości elektryczne i sposoby ich pomiaru Warszawa, WNT, 1995

3.
C. Barry Carter, M. Grant Norton, Ceramic materials: science and engineering, New York, Springer, 2013

4.
W. Kingery, H. Bowen, D. Uhlmann, Introduction to ceramics, 2nd edition, New York, Willey, 1976

	Supplementary literature	1. M. Marrony i in, "Proton-conduting ceramics, from fundamentals to applied research, Singapore, Pan Stanford Publishing, 2016 2. H. Rickerd Electrochemistry of solids: an introduction Berlin, Springer, 1982 3. S. Geller i in. Topics in applied phsyics vol 21: solid electrolytes Berlin, Springer, 1977 4. P. Gellings, H. Bouwmeester The CRC handbook of solid state electrochemistry New York, The CRC press, 1997 5. I. Riess Mixed ionic-electronic conductors materials properties and application Solid State Ionics 157 (2003) 1-17
	eResources addresses	Adresy na platformie eNauczanie: Przewodnictwo jonowe w kryształach 23/24 - Moodle ID: 23943 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=23943
Example issues/ example questions/ tasks being completed	1. Determining the dominant charge carrier2. Determining the conduction mechanism based on the measured characteristics3. Modeling of the structure of defects in a crystal and electrical properties	
Work placement	Not applicable	