GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Materials Science, PG_00068210						
Field of study	Biomedical Engineering						
Date of commencement of studies	October 2025		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	2		Language of instruction	Polish			
Semester of study	3		ECTS credits	4.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		prof. dr hab. inż. Ewa Wagner-Wysiecka				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	20.0	0.0	25.0	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	The aim of the course is to introduce students to the fundamentals of materials science. This includes the ability to select materials with specific properties for dedicated applications, particularly for problems related to biomedical engineering. The aim of the course is to understand the relationship between the structure/ composition of materials and their properties. The main objective of the laboratory classes is to familiarise students with the properties of selected materials and with the criteria required for them to perform their intended functions. The materials considered primarily are those used in analytical devices, sensors, protective layers, etc., as well as other materials applied in the field of medical sciences.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U52] can determine properties of materials and biomaterials used in biomedical engineering	As part of the laboratory classes, the student will acquire the ability to select appropriate materials according to their intended application, to determine the physical and physicochemical properties required for a material to fulfil specific functions, and to identify those characteristics of materials that are essential from the perspective of their anticipated use. The student will also learn to choose appropriate methods for assessing the suitability of materials and to recognise additional properties that, although not directly related to the primary function, may be significant—such as durability, corrosion resistance, or biological effects. The classes will raise awareness of the features of technical materials that determine their specific applications.	[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
[K6_W53] Knows and understands, to an advanced extent, selected aspects of materials science and biomaterials constituting general knowledge related to the field of study	The student understands the criteria for selecting materials for specific purposes and is familiar with the basic issues related to the production of materials for medical applications, including industrial processes subject to defined control. The student knows the fundamental sources of information on modern materials and is able to access them. The student possesses basic knowledge of materials and their properties, including mechanical, optical, and magnetic characteristics. The student understands the definition of material biocompatibility and is aware of the relationship between the structure of specific materials and their properties. The student is also aware of the potential use of materials with defined properties in medical applications.	[SW1] Assessment of factual knowledge

Subject contents

Course content – lecture

Lecture: Solid state physical and practical definitions, structure of solids. Chemical composition and structure. Elements of crystallography, crystal lattices, single crystals, polycrystals. Elements of symmetry. Crystallographic systems. Polymorphism, isomorphism, allotropes of elements, diamond, graphite, fullerenes, carbon nanotubes, isotropy and anisotropy. Metals, alloys, interstitial alloys, sintered materials and their applications, including in medicine and related sciences. Inorganic coatings on metals, corrosion. Ceramic materials and their applications in medicine. Amorphous materials, glasses, types and applications. Natural and synthetic fibres, organic and inorganic. Layers, manufacturing methods, monomolecular layers. Lipophilicity and hydrophilicity, wettability, lipo- and hydrophilic groups. Dispersed systems, emulsions, role of detergents. Colloids types, preparation, biological role. Osmosis, electroosmosis, deionisation of colloids, coagulation. Colloidal materials in medicine. Monomers, organic polymers, production methods. Types of polymerisation reactions, isomerism, cross-linked polymers. Condensation and addition polymers, biocompatibility. Copolymers, co-condensates. Chemical modification of polymers, ion-exchange resins. Examples of polymer applications in medicine. Reinforced plastics, introduction to composite materials. Relationships between structure and properties of plastics. Properties of materials: mechanical, thermal, electrical, magnetic, optical, biological. Industrial methods of material production. Process control and monitoring. Industrial synthesis of pharmaceutical preparations. Drug forms, manufacturing, quality assessment. Therapeutic systems.

Laboratory (1h introduction to laboratory classes; 8 exercises, 3h each)

1. Introduction
2. Visit to the GUMed Museum development of medical technologies and materials
3. Crystalline and amorphous materials, single crystal growth. Properties of glass.
4. Chemical and physical surface modification of ceramic materials and metals
5. Organic polymers, laboratory synthesis of a polymer
6. Organic polymers properties and identification
7. Preparation of nanomaterials
8. Metal corrosion

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Basic knowledge of chemistry that allows understanding of issues related to the structure and properties of materials.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Lecture: Written exam</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td>Laboratory: completion of all practical exercises and passing short tests</td><td>50.0%</td><td>50.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">1. J.F. Biernat Materiałoznawstwo Wydawnictwo PG 2014. 2. W. Kubiński Materiałoznawstwo (t. 1 i t.2) Wyd. AGH 2014. 3. Materiały ceramiczne, R. Pampuch, PWN Warszawa 1988. 4. Farmacja stosowana,5. S. Janicki, A. Fiebig, M. Sznitowska, Warszawa PZWL 2006. 6. Chemia, L. Pauling, P. Pauling, PWN Warszawa 1997. 7. Z. Florjańczyk, S. Pęczek (red.), Chemia polimerów tom I, II i III, Akademicka Oficyna Wydawnicza EXIT, Warszawa 2001. 8. J. Rabek, Polimery. Otrzymywanie, metody badawcze i zastosowania. PWN, 2013.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">Materials and literature references (current scientific publications) provided in the lecture materials.</td></tr>
<tr><td>eResources addresses</td><td colspan="2"></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3">1. Give an example of a substance that crystallises in the cubic system.
2. What is Kevlar? List its properties and indicate which structural features determine them.
3. What materials are used for protection against X-ray electromagnetic radiation?
4. Give three examples of biocompatible polymers.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="3">Not applicable</td></tr>
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