GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Modern functional materials, PG_00053350		
Field of study	Biomedical Engineering, Biomedical Engineering, Biomedical 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
Semester of study	3	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Chemistry and Technology of Functional Materials -> Faculty of Chemistry		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Ewa Wagner-Wysiecka	
	Teachers		

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	15.0	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	3.0	27.0	75

Subject objectives

The aim of the course is to present the relationship between the properties of functional materials, their chemical structure and production methods leading to functional materials with different properties and application areas: energy storage and conversion devices, electronics, photonics, medicine.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U52] can examine tissues, materials and biomaterials used in biomedical engineering	Student is able to choose the appropriate analytical method and apply it for the characterization of a specific group of materials	[SU5] Assessment of ability to present the results of task [SU1] Assessment of task fulfilment
[K7_U51] can conduct complex laboratory work connected with chemistry and biochemistry, specific to biomedical engineering	Student knows the laboratory workshop (preparation, measurements, characterization of materials) and is able to use laboratory and research methods to characterize materials	[SU4] Assessment of ability to use methods and tools [SU2] Assessment of ability to analyse information
[K7_W52] Knows and understands, to an increased extent, selected aspects of materials science and biomaterials, constituting general knowledge in the field of biomedical engineering	Student knows different types of materials and indicates the areas of their application in biomedical engineering	[SW1] Assessment of factual knowledge
[K7_K01] is ready to create and develop models of proper behaviour in the work and life environment; undertake initiatives; critically evaluate actions of their own, teams and organisations they are part of; lead a group and take responsibility for its actions; responsibly perform professional roles taking into account changing social needs, including:n - developing the achievements of the profession,n- observing and developing rules of professional ethics and acting to comply to these rulesn	Student is aware of the responsibility of professional work, understands the importance of making decisions in accordance with ethical and social standards	[SK1] Assessment of group work skills

Subject contents	**Lecture** 1. Definition and types of functional materials 2. Metals (groups I, II, transition metals) - bulk phases, metal nanoparticles - a redox activity series in aqueous and non-aqueous electrolytes for bulk metals and nanometals. 3. Semiconductors from the group of transition metal chalcogenides - characteristics of the bulk phase and 2-D nanomaterials. 4. Carbon materials - natural graphite, synthetic graphite, carbon nanomaterials, doped diamond, biomass derived pyrolytic carbons, graphene-like g-C_3N_4. 5. Methods of producing electrode layers from functional materials. Types of substrate, types of binder 6. Application of electrodes in electrochemical devices for energy storage and conversion 7. Macromolecules as functional materials. 8. Biomedical polymers: synthesis and their application areas. 9. Formulation, development & manufacturing of drug delivery systems. 10. Shape-memory and self-organization of functional materials. 11. Application of macromolecules in ultra- and nanofiltration. 12. Materials based on classical dyes and pigments vs. plasmon nanomaterials 13. Multifunctional photochromic materials and photoswitches. 14. Materials with magnetic properties 15. Surface functionalized materials 16. Applications of selected optical active materials: sensors, actuators, fotovoltaic cells, optoelectronic devices 17. Bioinspired functional materials **Project** Design of device for biomedical applications based on a selected group of functional materials. Two presentations: 1. literature review and design assumptions 2. overview of the proposed design solution, discussion of the results **Laboratories** 1. Preparation, characterization and applications of optical active materials - carbon dots 2. Gas sorption and detection with the use of organometallic porous materials MOFs 3. Synthesis and properties analysis of polymers for biomedical applications 4. Methods of obtaining and potential application of polymer membranes and nanomembranes 5. Synthesis and characterization of materials for dye solar cells
Prerequisites and co-requisites	Knowledge of chemistry, biochemistry, basic analytical methods. Ability to use basic laboratory equipment.
Assessment methods and criteria	

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture - written colloquium covering the issues discussed during the lecture	51.0%	40.0%
Project - two presentations: 1. literature review and design assumptions 2. discussion of the proposed design solution, discussion of the results	51.0%	30.0%
Laboratory -participation in all laboratory exercises and passing appropriate tests	100.0%	30.0%

Recommended reading	Basic literature	1. Recent Advances in Complex Functional Materials. From Design to Application, E. Longo, F. de Almeida La Porta (Eds.), Springer International Publishing AG 2017, ISBN 978-3-319-53898-3 (eBook), DOI 10.1007/978-3-319-53898-3 2. X. D. Liu, A. R. Esker, M. Häußler, Ch. Kim, P. Lucas, M. Matsunaga, N. Nishi, J.-J. Robin, B. Z. Tang, D. A. Wang, M. Yamada, H. Yu, Functional Materials and Biomaterials, Springer-Verlag Berlin Heidelberg 2007, DOI 10.1007/978-3-540-71509-2 3. Magnetism and Structure in Functional Materials, A. Planes, L. Mañosa, A. Saxena (Eds.), Springer-Verlag Berlin Heidelberg 2005, 978-3-540-31631-2 (eBook), DOI 10.1007/3-540-31631-0 4. R. D. Munje, S. Prasad, E. Graef, Functional Materials: For Sensing/Diagnostics, w: Handbook of Solid State Chemistry, R. Dronskowski, S. Kikkawa, A. Stein (Eds.), WileyVCH Verlag GmbH & Co. KGaA 2017, DOI: 10.1002/9783527691036 5. V. Sudarsan, Optical Materials: Fundamentals and Applications, w: Functional Materials. Preparation, Processing and Applications, str. 285-322, Elsevier Inc. 2012, DOI 10.1016/C2010-0-65659-8 6. Handbook of Smart Materials in Analytical Chemistry, M. de la Guardia, F. A. EsteveTurrillas (Eds.), John Wiley & Sons Ltd, 2019 7. S.O. Kasap, K. Koughia, Jai Singh, Harry E. Ruda, Asim K. Ray, Fundamental Optical Properties of Materials I, w: Optical Properties of Materials and Their Applications, J. Singh (Ed.), John Wiley & Sons Ltd, 2020, str. 1-36. DOI 10.1002/9781119506003.ch1 8. S.O. Kasap, K. Koughia, Jai Singh, Harry E. Ruda, Asim K. Ray, Fundamental Optical Properties of Materials II, w: Optical Properties of Materials and Their Applications, J. Singh (Ed.), John Wiley & Sons Ltd, 2020, str. 37-65. DOI 10.1002/9781119506003.ch2 9. J. M. Hvam, Optoelectronic Properties and Applications of Quantum Dots, w: Optical Properties of Materials and Their Applications, J. Singh (Ed.), John Wiley & Sons Ltd, 2020, str. 503-536. DOI 0.1002/9781119506003.ch17 10. M. A. J. Mazumder, H. Sheardown, A. Al-Ahmed, Functional Polymers, Springer, Cham 2019, ISBN 978-3-319-95987-0, DOI: 10.1007/978-3-319-95987-0 11. Instrukcje do ćwiczeń laboratoryjnych
	Supplementary literature	1. M. Chen, X. Fu, Z. Chen, J. Liu, W. H. Zhong, Protein-Engineered Functional Materials for Bioelectronics, *Advanced Functional Materials*, 31, (2021), 2006744.DOI 10.1002/adfm.202006744 2. A. Edgar, Optical Properties of Glasses w: Optical Properties of Materials and Their Applications, J. Singh (Ed.), John Wiley & Sons Ltd, 2020, str. 83-128. DOI 0.1002/9781119506003.ch4 3. T. Aoki, Photoluminescence w: Optical Properties of Materials and Their Applications, J. Singh (Ed.), John Wiley & Sons Ltd, 2020, str. 157-202. DOI 10.1002/9781119506003.ch6 4. D. Xiao, L. Gu, Origin of functionality for functional materials at atomic scale, *NanoSelect*, 1, (2020) 183-199. DOI 10.1002/nano. 202000020 5. A. Moores, F. Hajiali, T. Jin, G. Yang, M. Santos, E. Lam, Mechanochemical Transformations of Biomass into Functional Materials, *ChemSusChem*, w druku, (2022) DOI 10.1002/cssc. 202102535 6. J. Kawamata, Y. Suzuki, M. Tominaga, From Adsorbed Dyes to Optical Materials, *Developments in Clay Science*, 9 (2018) 361-375. DOI 10.1016/B978-0-08-102432-4.00011-1 7. L.Y. Chu, R. Xie, X. J. Ju, W. Wang, Smart Hydrogel Functional Materials,Chemical Industry Press, Beijing and Springer Berlin Heidelberg 2013, ISBN 978-3-642-39538-3 (eBook), DOI 10.1007/978-3-642-39538-3 8. M. Jenkins, Biomedical polymers, Woodhead Publishing Series in Biomaterials 2007, ISBN-10:1845690702 9. T. A. Saleh, V. K. Gupta, Nanomaterial and Polymer Membranes: Synthesis, Characterization, and Applications, Elsevier 2016, ISBN: 0128047038 10. Cornelia Breitkopf; Karen Swider-Lyons, Springer Handbook on Electrochemical Energy, Springer 2016. 11. A. S. Aricò, P. Bruce, B. Scrosati, J. M. Tarascon, and W. Van Schalkwijk, Nanostructured materials for advanced energy conversion and storage devices, *Nature Materials*, vol. 4, no. 5, pp. 366377, 2005.
	eResources addresses	Adresy na platformie eNauczanie:
Example issues/ example questions/ tasks being completed	j.w.	
Work placement	Not applicable	