Warsaw University
of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-00DEGIK-0015	Name of the course	Polish	Funkcjonalne struktury hybrydowe i nanokompozytowe do zastosowań w biotechnologii i dziedzinach pokrewnych
			English	Functional hybrid and nanocomposite structures for the application in biotechnology and related fields

Type of the course	specialized				
Course coordinator	Dr hab. inż. Agnieszka M. Jastrzębska, Prof. uczelni				
Implementing unit	Faculty of Materials Science and Engineering	Scientific discipline / disciplines*	materials engineering, chemical sciences, chemical engineering, biomedical engineering, environmental engineering, mining and power engineering		
Level of education	Education of PhD students	Semester	winter		
Language of the course	English				
Type of assessment:	Grade on a basis of abstract and presentation evaluation	Number of hours in a semester	15	ECTS credits	1
Minimum number of participants	12	Maximum number of participants	-	Available for students (BSc, MSc)	No

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	2				
	in a semester	15				

* does not apply to the Researcher's Workshop

1. Prerequisites

General knowledge on the basics of materials science, including knowledge on: nanomaterials and nanotechnology, nanomaterials characterisation techniques, nanomedicine, biomaterials, and biotechnology.

2. Course objectives

Nanocomposites are heterogeneous materials with structure and composition much more complicated in comparison to their traditional micro- and macroscopic counterparts. Nanomaterials are a robust and flexible platform for designing new types of hybrid structures with various biological properties and functionalities which are in turn determined by a variety of features. This makes them suitable for application in biotechnological areas, especially in disinfection, diagnosis and treatment of different diseases and disorders, also including novel targeted drug delivery systems. Design and construction of such multi-purpose hybrids involve the need for understanding the influence of each step on expected and also potentially unexpected properties. Incorporation of specific synthesis techniques involving multifunctional moieties for targeting and control the delivery of the entrapped bioactive substances makes it far more difficult. Therefore, the course aims at familiarizing the PhD students with types of nanocomposite and nanohybrid structures, methods of their synthesis, resulting in targeted properties as well as the important issue of minimizing any potentially harmful side effects.

3. Course content (separate for each type of classes)

Lecture

General description of the subject:

The subject covering selected issues in the field of nanotechnology for biotechnological application and related fields, implementing knowledge, skills and competences related to the specificity of applying nanomaterials as bioactive substances in selected areas of nanomadicine. The subject contains general and specialized experimental knowledge, development trends and current directions in this field.

Educational contents

Selected issues in the field of nanomaterials for the application in biotechnological areas, especially in disinfection, diagnosis and treatment of different diseases and disorders, also including novel targeted drug delivery systems.

Topics of 14 lectures:

Lecture 1. The future of nanotechnology in industry and biotechnological fields, 2g

Lecture 2. Designing multifunctional nanoparticles for biomedical applications, 1g

Lecture 3. Description and division of functional hetero/hybrid-structured nanoparticles, 1g

Lecture 4. Different classes of properties and functions of nanoparticles utilized for biomedical applications, 1g

Lecture 5. Examples of NPs' functional combinations for biomedical applications, 1g

Lecture 6. Nanostructures for the application as disinfecting agents, 1g

Lecture 7. Nanostructures in diagnosis and treatment of various diseases and disorders, 1g

Lecture 8. General biological barriers for NPs delivery, 1g

Lecture 9. Selection of methods for obtaining functional hybrid and nanocomposite structures, 1g

Lecture 10. Discussion on nanomaterial parameters that can influence biological properties of nanostructures, 1g

Lecture 11. Understanding the expected and unexpected mechanisms of nanotoxicity action, 1g

Lecture 12. Revisiting the generation of reactive oxygen species, 1g

Lecture 13. Current trends in the development of functional hybrid and nanocomposite structures for the application in biotechnology and related fields, 1g

Lecture 14. Conclusion and future outlook, 1g

Lecture 15. Meeting aimed to checking students knowledge.

Laboratory
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4. Learning outcomes			
	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	to the extent enabling the revision of the existing paradigms - global achievements, including theoretical foundations and general issues and selected specific issues - appropriate for the represented scientific discipline, including the latest scientific achievements in the field of research	SD_W2 P8S_WG	Individually prepared presentation on a relevant paper and the corresponding abstract. To be verified if the PhD student knows the development tendencies of the optimization of properties with the use of engineering methods and biological knowlegde.
K02	main development trends of the research discipline pursued and related research methodologies	SD_W3 P8S_WG	To be verified during individual presentation, if the PhD student knows modern methods of designing the structure of nanomaterials and methods of controlling their properties.

Skills			
S01	communicate on specialist topics relevant to the represented scientific discipline to a degree enabling active participation in the national and international scientific community, including international consortia of research universities	SD_U4 P8S_UK	Discussion with peers on the presented type of hybrid-structured nanomaterial. To be verified if the PhD student is able to analyze the collect information, make its interpretation and critical evaluation as well as draw right conclusions and formulate/justify the opinion.
S02	use English at the B2 + level of the European System for the Description of Languages to a degree enabling participation in the international scientific and professional environment	SD_U6 P8S_UK	Individually prepared study and assumptions on the selected scientific paper. Discussions with peers. To be verified if the PhD student has the ability to prepare and present a consolidated scope of work in English on selected issue in the field of materials engineering, based on English-language literature.
Social competences			
SC01	critical evaluation of the achievements of the represented scientific discipline, including one's own contribution to the development of this discipline	SD_K1 P8S_KK	The PhD student is able to analyze the collect information, make its interpretation and critical evaluation as well as draw right conclusions and formulate/justify the opinion.

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Individually prepared PPT presentation and the abstract; mark: 2-5.

6. Literature
Basic literature:
[1] P. P. Fu, Q. Xia, H.-M. Hwang, P. C. Ray, H. Yu, Mechanisms of nanotoxicity: Generation of reactive oxygen species, Journal of Food and Drug Analysis 22 (2014) 64-75, doi: 10.1016/j.jfda.2014.01.005, Copyright 2014 Food and Drug Administration, Taiwan. Published by Elsevier Taiwan LLC.
[2] D. Kim, K. Shin, S. G. Kwon, T. Hyeon, Synthesis and Biomedical Applications of Multifunctional Nanoparticles, Advanced Materials 30 (2018) 1802309, doi: 10.1002/adma.201802309, Copyright 2018 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

[3] H. Mohammad-Beigi, C. Scavenius, P. B. Jensen, K. Kjaer-Sorensen, C. Oxvig, T. Boesen, J. J. Enghild, D. S. Sutherland, Y. Hayashi, Tracing the In Vivo Fate of Nanoparticles with a “Non-Self” Biological Identity, ACS Nano 14 (2020) 10666−10679, doi:10.1021/acsnano.0c05178, Copyright 2020 American Chemical Society.

Additional literature:

[1] K. Schirmer, Chapter 6: Mechanisms of Nanotoxicity, Frontiers of Nanoscience, Vol. 7. Doi: 10.1016/B978-0-08-099408-6.00006-2, Copyright 2014 Elsevier Ltd.

[2] A. M. Jastrzębska, P. Kurtycz, A. R. Olszyna, Recent advances in Graphene Family Materials toxicity investigations, Journal of Nanoparticle Research 14, 12 (2012) 1-21

7. PhD student’s workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	15
2	Hours of consultations with the academic teacher, exams, tests, etc.	2
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	5
4	Amount of time devoted to the preparation for exams, test, assessments	5
	Total number of hours	**27**
	ECTS credits	**1**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)