

Warsaw University of Technology | Doctoral School No. 1

Course offered in the Doctoral School No. 1
– Spring semester of the 2021/2022 academic year

TITLE
Functional Hybrid and Nanocomposite Structures for the Application in Biotechnology and Related Fields
CONDUCTING UNIT
Doctoral School No. 1
SCIENTIFIC DISCIPLINE
Materials engineering
IMPLEMENTING UNIT
109000 - Faculty of Materials Science and Engineering
FULL DESCRIPTION
<p>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 facile synthesis routes 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.</p> <p>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.</p>

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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
3. 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.
4. 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.
5. 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.

LEARNING OUTCOMES

Category: knowledge

- The PhD student has in-depth knowledge of the structure and properties of nanomaterials. PhD student knows the factors influencing the biological properties of nanomaterials and methods of controlling their properties, and processes taking place within the nano-bio interfaces. PhD student knows the methods of assessment of nanomaterials' biological properties. PhD student understands the relationship between the structure of nanomaterial and its bioactive properties. PhD student knows the ways of shaping the properties of nanomaterials by controlling the morphology, structure, and attached biological moieties.
- The PhD student knows modern methods of designing the structure of nanomaterials and methods of controlling their properties. PhD student knows the development tendencies of the optimization of properties with the use of engineering methods and biological knowledge.
- Method of verifying the effect: Individually prepared presentation of a relevant paper and the abstract. Discussion on the presented type of hybrid-structured nanomaterial.

Category: skills

- The PhD student is able to obtain information from English-language literature and other properly selected resources in order to describe a specific scientific and/or technical issue.
- The PhD student is able to analyze the collected information, make its interpretation and critical evaluation as well as draw right conclusions and formulate/justify the opinion.
- 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.
- Method of verifying the effect: Individually prepared study and assumptions on the selected scientific paper. Discussions with peers.

Category: competences

- The PhD student understands the necessity of development of practical knowledge in English language, including the presentation of papers and discussion after the presented paper in English.
- The PhD student understands the importance of optimizing the structure of nanomaterials in terms of biological properties using modern technologies based on scientific knowledge, including methods of nano-engineering and other nanotechnological techniques.
- The PhD student also understands the importance of property optimization for the rational design of engineered nano-structures.

LANGUAGE OF THE COURSE		ECTS CREDITS
English		3
TYPE OF CLASSES	NUMBER OF HOURS	COURSE INSTRUCTOR
Lecture	15	Agnieszka Jastrzębska, dr hab. inż., prof. uczelni