GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Advanced methods of synthesis and analysis of polymer nanocomposites, PG_00072666		
Field of study	Chemical Technology, Chemistry, Biotechnology, Engineering and Technologies of Energy Carriers, Corrosion , Green Technologies, InfoBioChem		
Date of commencement of studies	February 2026	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	English The lecturer is prepared to conduct the course in both English and Polish.
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Polymer Technology -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Michał Strankowski	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	0.0	15.0	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	5.0	15.0	50

Subject objectives

The objective of the course is to provide students with advanced knowledge of synthesis strategies for polymer nanocomposites and modern methods for their structural, thermal, and mechanical characterization. The course aims to develop skills in designing nanocomposite materials with specific properties, as well as the critical analysis of scientific literature and the presentation of project work results.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W05] recognises the key developments in research, apparatus and technology in technology and related fields	recognizes modern trends in synthesis (in situ, melt blending) and utilizes the latest scientific achievements described in specialized literature within their project work.	[SW2] Assessment of knowledge contained in presentation
[K7_K82] is equipped to participate actively in lectures, seminars and laboratory classes conducted in foreign language	actively participates in lectures and project discussions conducted in English, correctly using terminology from the field of polymer nanotechnology.	[SK4] Assessment of communication skills, including language correctness
[K7_W101] is able to make an in-depth identification of key objects and phenomena related to the field of study, as well as theories that describe them and applicable analytical and design methods	knows and identifies types of nanofillers (e.g., CNT, graphene) and selects advanced research methods (TEM, SEM, AFM, XRD, MDSC) for the analysis of the structure and properties of nanocomposites.	[SW3] Assessment of knowledge contained in written work and projects
[K7_K02] understands the non-technical aspects and implications of graduate activity, including the impact on the environment	demonstrates awareness of toxicological and environmental aspects related to the production and disposal of nanomaterials, incorporating them into the project.	[SK5] Assessment of ability to solve problems that arise in practice

<table>
<tr><td>Subject contents</td><td>Course content – lecture
Introduction and classification of polymer nanocomposites; types of fillers (nanosilica, carbon nanotubes, graphene, layered silicates, metal nanoparticles).
Synthesis strategies: in situ polymerization, solution blending, and melt blending.
Chemical surface modification of fillers to improve dispersion and compatibility with the polymer matrix.
Morphological and structural characterization: electron microscopy (TEM, SEM), atomic force microscopy (AFM), and X-ray diffraction (XRD).
Advanced thermal analysis: Modulated Differential Scanning Calorimetry (MDSC), and TGA coupled with MS or FTIR (TGA-MS/TGA-FTIR).
Mechanical properties analysis: Dynamic Mechanical Analysis (DMA).
Nanocomposites with special properties: electrically conductive, barrier properties, and flame retardancy.
Industrial and biomedical applications of polymer nanocomposites. Toxicological and environmental aspects of nanomaterials.

Course content – project
Work in small groups on a specific project assignment.
Task: Based on scientific literature, students will design a polymer nanocomposite for a specific application (e.g., biodegradable packaging with enhanced barrier properties, flexible conductive material for wearable electronics).
The project includes the selection of the polymer matrix and filler, a proposal for a synthesis method with justification, and a material characterization plan.
The final outcome is a written report and an oral presentation.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Established knowledge of polymer chemistry and physics, as well as the fundamentals of instrumental analytical methods.</td></tr>
<tr><td>Assessment methods and criteria</td><td>
<table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Final Project (written report and oral presentation)</td><td>50.0%</td><td>50.0%</td></tr>
<tr><td>Lecture - written exam</td><td>50.0%</td><td>50.0%</td></tr>
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<tr><td>Recommended reading</td><td>
<table>
<tr><td>Basic literature</td><td>1. Ajayan, P. M., Schadler, L. S., & Braun, P. V. (2003). Nanocomposite Science and Technology. Wiley-VCH.
2. Pascault, J. P., & Williams, R. J. (Eds.). (2010). Polymer Nanocomposites: From Synthesis to Applications. Wiley-VCH.
3. Current literature database (ex. Progress in Polymer Science, Advanced Materials, Polymer Reviews).</td></tr>
<tr><td>Supplementary literature</td><td>-</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
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<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Compare the in situ polymerization method and melt blending for the production of polyamide/ montmorillonite nanocomposites. Indicate the advantages and disadvantages of both approaches.
2. How can TEM and XRD techniques be used to confirm the formation of an exfoliated or intercalated structure in a nanocomposite?
3. Propose a material system for a lightweight, electrically conductive composite for aerospace applications. Justify your choice of matrix and nanofiller.
4. Discuss the phenomenon of the percolation threshold in the context of polymer nanocomposites with the addition of carbon nanotubes.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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