GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	MODERN INORGANIC PREPARATIVE METHODS, PG_00064387		
Field of study	Chemistry		
Date of commencement of studies	October 2026	Academic year of realisation of subject	2027/2028
Education level	first-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 Inorganic Chemistry -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. inż. Rafał Grubba	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	0.0	15.0	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	25.0	75

Subject objectives

The aim of the course is to introduce students to modern methods for the synthesis, isolation, and characterization of inorganic, coordination, organometallic, and MOF materials, as well as to develop skills in planning and conducting syntheses using contemporary preparative techniques.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_U03] operates typical laboratory apparatus and carries out analyses to identify chemical compounds and materials, integrating computational methods and application software	Can operate standard preparative and analytical laboratory equipment and apply basic instrumental methods for the synthesis, characterization, and identification of inorganic compounds and materials.	[SU4] Assessment of ability to use methods and tools
[K6_W02] classifies acquired information, assessing its usefulness in solving the posed problems concerning the synthesis and analysis of selected groups of compounds, determining their physical and chemical properties, making measurements and determining the parameters of chemical reactions and processes	Has the necessary knowledge to select and evaluate information in terms of its usefulness for planning a synthesis, analysis, and characterization of inorganic compounds and in determining the parameters of chemical reactions and processes.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation
[K6_W06] identifies trends in research and scientific apparatus in the fields of science and scientific disciplines relevant to chemistry and chemical engineering	Has the necessary knowledge to identify trends in the development of modern synthetic methods and research instrumentation used in the preparation and characterization of inorganic compounds and materials.	[SW1] Assessment of factual knowledge [SW2] Assessment of knowledge contained in presentation
[K6_U09] is able to recognise hazards, counteract them and work with chemical reagents and basic technical apparatus in accordance with health and safety principles and the concept of sustainability	Can identify hazards associated with working with chemical reagents and laboratory equipment and apply health and safety and sustainable development principles when conducting chemical syntheses.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject

Subject contents	Course content – lecture The lecture will cover modern methods for the synthesis and isolation of inorganic, coordination, organometallic, and hybrid materials. Particular attention will be given to the principles of synthetic planning based on the electronic and steric properties of reagents and products. The synthesis of coordination compounds of transition metals and main-group elements will be discussed, including methods for controlling coordination geometry and metal oxidation state. The course will cover the synthesis of complexes containing mono- and multidentate ligands, π-donor ligands, and ligands with unusual electronic properties. Basic and advanced methods for the synthesis of organometallic compounds will also be presented. A separate module will focus on methods for the preparation of metal–organic frameworks (MOFs), including the selection of metal ions or clusters, organic linkers, and crystallization conditions. Solvothermal, hydrothermal, microwave-assisted, mechanochemical, and sonochemical methods will be discussed. Methods for the synthesis of porous and hybrid materials, as well as approaches to controlling their structure, crystal size, and surface properties, will also be presented. The lecture will additionally cover selected modern methods for the synthesis of organoboron, organophosphorus, and organosilicon compounds, with particular emphasis on compounds exhibiting unusual structures and reactivity. Methods for handling air- and moisture-sensitive substances, conducting reactions under an inert-gas atmosphere, and using vacuum and high-pressure techniques will be discussed. Modern methods for purification, crystallization, and isolation of reactive inorganic compounds will also be presented. Course content – laboratory The laboratory will provide practical training in modern methods for the preparation of inorganic compounds. Students will synthesize selected coordination compounds of transition metals with organic ligands and carry out their isolation and basic characterization. One of the experiments will focus on the synthesis of an organometallic compound using techniques that allow reactions to be conducted under a controlled atmosphere. In addition, the laboratory will provide training in techniques for working under an inert-gas atmosphere. Another experiment will involve the preparation of a metal–organic framework (MOF) using a hydrothermal or solvothermal method and the analysis of the influence of synthetic conditions on the properties of the resulting material. Students will become familiar with methods for the crystallization and isolation of products, including the selection of appropriate solvents, temperature, and cooling rate. Depending on the experimental program, an additional experiment may involve the synthesis of a selected organoboron, organophosphorus, or organosilicon compound. An integral part of the laboratory will be the characterization of the synthesized products using available instrumental techniques, such as IR spectroscopy, NMR spectroscopy, UV-Vis spectroscopy, mass spectrometry, elemental analysis, and X-ray diffraction. Students will analyze experimental data and compare them with the expected structure of the products. The laboratory will conclude with the preparation and discussion of experimental results, including an assessment of the yield and selectivity of the syntheses performed. Course content – seminar The seminar will focus on the analysis of modern methods of inorganic synthesis based on selected examples from the scientific literature. Students will become familiar with strategies for planning the synthesis of coordination compounds, organometallic compounds, and MOF materials. The selection of substrates, ligands, solvents, temperature, reaction time, and reaction atmosphere will be discussed. Particular attention will be given to the relationship between synthetic conditions and the structure and properties of the products obtained. The seminars will include examples of the synthesis of transition-metal and main-group coordination compounds, organometallic compounds, and selected molecular catalysts. Students will examine methods for the synthesis and characterization of MOFs and their applications in catalysis, adsorption, and separation. Selected examples of the synthesis of organoboron, organophosphorus, and organosilicon compounds with unusual structural and electronic properties will also be discussed. An important component of the seminars will be the analysis of scientific publications describing new preparative methods. Students will prepare presentations describing the synthetic strategy, reaction mechanism, product isolation procedure, and analytical techniques used. The discussion will also address the advantages and limitations of individual methods and their possible modification and application to other systems.
Prerequisites and co-requisites	

<table>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Lecture – colloquium</td><td>60.0%</td><td>40.0%</td></tr>
<tr><td>Seminar – presentation</td><td>60.0%</td><td>20.0%</td></tr>
<tr><td>Laboratories – report</td><td>60.0%</td><td>40.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>C. E. Housecroft, A. G. Sharpe, Inorganic Chemistry, Pearson, 2018.

R. H. Crabtree, The Organometallic Chemistry of the Transition Metals, John Wiley & Sons, 2014

O. M. Yaghi, M. J. Kalmutzki, C. S. Diercks, Introduction to Reticular Chemistry: Metal-Organic Frameworks and Covalent Organic Frameworks, Wiley-VCH, 2019</td></tr>
<tr><td>Supplementary literature</td><td>-</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">• Planning and carrying out the synthesis of a coordination compound – selection of substrates, ligands, solvent, and reaction conditions, followed by selection of appropriate methods for product isolation and characterization.
• Synthesis and characterization of a MOF material – selection of the metal ions and organic linker, optimization of the synthetic conditions, and analysis of the structure and properties of the resulting material.
• Selection of a modern preparative method for an air- and moisture-sensitive compound – planning the synthesis using inert-gas techniques and selecting appropriate methods for product purification and characterization.</td></tr>
<tr><td>Practical activites within the subject</td><td colspan="2">Not applicable</td></tr>
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