GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Organometallic chemistry, PG_00069253						
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	Polish			
Semester of study	2		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	20.0	0.0	10.0	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 familiarize students with the structure, properties and applications of coordination compounds, with particular emphasis on organometallic compounds. The program focuses on developing skills in designing new compounds and developing innovative strategies for their preparation. The course includes a series of lectures, seminars and laboratory classes, during which issues related to the importance of organometallic compounds in chemical synthesis, catalysis, materials chemistry and medicine will be discussed. Both teamwork and individual cooperation with a teacher facilitate the development of practical technical and analytical competences, as well as improving the skills of presenting research results and preparing reports from conducted experiments.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U02] prepares detailed documentation of the results of independently conducted experiments and analyzes the obtained results, uses professional vocabulary with understanding and prepares and communicates information	is able to prepare a report on the performed syntheses of organometallic compounds.	[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
[K7_W01] recognizes problems of modern chemistry, including properties and obtaining chemical compounds, necessary for making calculations, including the dependence of the compound's structure and its reactivity	has knowledge of the correlations between the structure of an organometallic compound and its chemical properties.	[SW1] Assessment of factual knowledge
[K7_U01] integrates and interprets information from literature, databases and other sources	is able to plan the synthesis of an organometallic compound based on scientific publications and using the Reaxys database.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task
[K7_K02] is able to cooperate and work in a group, taking on different roles	is ready to work effectively as part of a team on projects related to the synthesis of organometallic compounds.	[SK5] Assessment of ability to solve problems that arise in practice [SK4] Assessment of communication skills, including language correctness [SK3] Assessment of ability to organize work [SK2] Assessment of progress of work [SK1] Assessment of group work skills
[K7_W04] indicates methods for the synthesis of chemical compounds with defined properties	has the knowledge necessary to design organometallic compounds with specified structures and properties using advanced methods of inorganic and organic synthesis.	[SW3] Assessment of knowledge contained in written work and projects [SW2] Assessment of knowledge contained in presentation [SW1] Assessment of factual knowledge
[K7_U03] plans and performs the synthesis of chemical compounds with the required properties	is able to perform multi-step syntheses of organometallic compounds under anhydrous and oxygen-free conditions using the Schlenk technique.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

Subject contents

Course content – lecture
LECTURE:
The course covers the basics of coordination and organometallic chemistry. The first part discusses issues related to the structure, nomenclature, isomerism, and physicochemical properties of d-block metal complexes. The second part is devoted to selected classes of ligands and organometallic compounds, along with the basics of their synthesis.
Topics covered in the lecture:
1. Coordination compounds:
- Basic concepts
- Nomenclature of complex compounds
- Equilibrium in solutions of complex compounds
- Isomerism of complex compounds
- Crystal field theory
- Color and magnetic properties of d-block metal complexes

2. Organometallic compounds:
- Phosphines as ligands
- N-heterocyclic carbenes as ligands
- Metal carbonyls
- Alkenes as ligands
- Aromatic hydrocarbons as ligands
- Organolithium and organomagnesium compounds
- Organoboron compounds
- Organosilicon compounds
- Basics of preparation of organometallic compounds

Course content – laboratory
LABORATORY:
Classes include the synthesis of transition metal compounds containing selected classes of ligands, such as cyclopentadienyl, olefin, phosphine and carbene ligands, as well as their identification by spectroscopic methods (NMR, UV-Vis, IR). They are practical in nature and are aimed at independent planning and implementation of synthetic experiments. The selection of specific syntheses is made in consultation with students, taking into account their interests and current technical possibilities. The summary of the series of meetings is a prepared concise report describing the experiments and analyses performed.

Course content – seminar
SEMINAR:
The classes aim to develop skills in interpreting scientific literature in the field of organometallic chemistry. Students learn to critically evaluate publications, analyze the data contained in them, and present research results in a clear and objective manner. The work is based on independent selection and discussion of a scientific article from a renowned journal from the JCR or Scopus list that falls within the topic indicated by the instructor, and then on a joint discussion.
Topics discussed during the seminar:
- Metal complexes with phosphines (synthesis and catalytic properties)
- Organophosphorus and organoarsenic compounds (synthesis and application as plant protection agents or in medicine)
- Metal carbonyls (synthesis and catalytic properties; application in medicine)
- Metal complexes with unstable carbenes (synthesis and catalytic properties)
- Metal and nonmetal complexes with N-heterocyclic carbenes (synthesis and catalytic properties, application in medicine)
- Metal cyclopentadienyl complexes (synthesis and catalytic properties; application in medicine)
- Organolithium compounds (synthesis)
- Organograinium compounds (synthesis)
- Organoboron compounds (synthesis and catalytic properties)
- Organaluminium compounds (synthesis and catalytic properties)
- Organosilicon compounds (synthesis and application)
- Nobel Prizes in Chemistry organometallic
- Metal clusters - discussion of selected examples
- Organometallic polymers - discussion of selected examples

Prerequisites and co-requisites

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Seminar - Evaluation of a Student's Presentation	50.0%	20.0%
Lab – Synthesis Knowledge Test; Final Report	50.0%	50.0%
Lecture - written colloquium	50.0%	30.0%

Recommended reading

Basic literature	- P. Atkins, L. Jones, Chemia Ogólna, PWN - A. Bielański, Podstawy Chemii Nieorganicznej, PWN - B. D. Gupta, A. J. Elias, Basic organometallic chemistry. Concepts, syntheses and aplications, Universities Press
Supplementary literature	- D. Astruc, Organometallic chemistry and catalysis, Springer
eResources addresses	

Example issues/ example questions/ tasks being completed	• Phosphines and amines are important ligands in coordination chemistry. Give one example each for a phosphine and an amine. Give their names, Lewis structure, molecular shape, and nitrogen-phosphorus hybridization. Determine whether these compounds oxidize in the presence of air. Write the Lewis structure of the oxidation products. Describe how phosphines and amines bind to transition metal ions (describe similarities and differences in the nature of the bonds). • The following pairs of complexes are given. Determine which of the complexes is more stable in a given pair using the theory of soft and hard Lewis acids. Justify your answer. Give names for the complexes listed. $[FeF_6]^{3-}$ i $[FeCl_6]^{3-}$ $[HgI_4]^{2-}$ i $[HgCl_4]^{2-}$ $[Pt(NEt_3)_4]$ i $[Pt(PEt_3)_4]$ • Describe the structure and methods for obtaining NHC-carbenes using a selected carbene as an example. • A student, while synthesizing a compound sensitive to oxidation and hydrolysis, needs to transfer a large amount of solution from one reaction flask to another. Help the student: write what equipment is needed and describe the procedure for transferring a large amount of solution under the required conditions. You can make an illustrative drawing.
Practical activites within the subject	Not applicable

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