UNIVERSITATEA BABEŞ-BOLYAI
BABEŞ-BOLYAI TUDOMÁNYEGYETEM
BABEŞ-BOLYAI UNIVERSITÄT
BABEŞ-BOLYAI UNIVERSITY
TRADITIO ET EXCELLENTIA

Tradiție și Excelență prin
Cultură - Știință - Inovație din 1581

Facultatea de Chimie și Inginerie Chimică

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SYLLABUS

Functional Materials

University year 2025/2026

1. Information regarding the programme

1.1. Higher education institution	Babeş-Bolyai University (BBU), Cluj-Napoca, Romania, in partnership with Technische Universität Chemnitz (TUC), Chemnitz, Germany
1.2. Faculty	Chemistry and Chemical Engineering
1.3. Department	Chemistry
1.4. Field of study	Chemistry
1.5. Study cycle	Master
1.6. Study programme/Qualification	Advanced Chemical Process Engineering (ACPE) / Master's Degree
1.7. Form of education	Full-time education

2. Information regarding the discipline

2.1. Name of the discipline	**Functional Materials**					Discipline code	**CME6139**
2.2. Course coordinator				Prof. Dr. Cristian Silvestru (BBU) Prof. Dr. Michael Mehring (TUC)			4, 12
2.3. Seminar coordinator				Lect. Dr. Eng. Lucian-Cristian Pop (BBU) (including course) Lect. Dr. Ionuț-Tudor Moraru (BBU)			
2.4. Year of study	2	2.5. Semester	4	2.6. Type of evaluation	E	2.7. Discipline regime	SD

3. Total estimated time (hours/semester of didactic activities)

3.1. Hours per week	**4**	of which: 3.2 course	**2**	3.3 seminar/laboratory	**2**
3.4. Total hours in the curriculum	56	of which: 3.5 course	28	3.6 seminar/laboratory	**28**
Time allotment for individual study (ID) and self-study activities (SA)					**hours**
Learning using manual, course support, bibliography, course notes (SA)					30
Additional documentation (in libraries, on electronic platforms, field documentation)					14
Preparation for seminars/labs, homework, papers, portfolios and essays					14
Tutorship					7
Evaluations					4
Other activities:					-
3.7. Total individual study hours	**69**				
3.8. Total hours per semester	**125**				
3.9. Number of ECTS credits	**5**				

4. Prerequisites (if necessary)

4.1. curriculum	• Not the case.
4.2. competencies	• Estimated personal level of English using Common European Framework of Reference for Languages (CEFR) should be minimum B1.

5. Conditions (if necessary)

5.1. for the course	• Students will attend the courses having the materials (*e.g.* videos) made available prior to each course

	• During the lecture students are asked to mute their mobile phones
5.2. for the seminar /lab activities	• Students will attend the seminar with the course notes referring to the seminar topic • During the seminar/practical work activities students are asked to mute their mobile phones

6. Specific competencies acquired [1]

Professional/essential competencies	• Definition of notions, concepts, theories and advanced models in the field of material chemistry as well as their proper use within the professional community • Application and interpretation of the properties of inorganic chemistry/organic-inorganic hybrid materials /organometallic chemistry as well as concepts, approaches and phenomena related to material chemistry • Identification and proper usage of concepts, method and theories for solving new complex problems of material chemistry / Functional Materials • Use of advanced knowledge in the field of material chemistry to determine, explain and interpret the structure, properties, and potential application of Functional Materials • Critical analysis and usage of principles, methods and advanced work techniques to solve specific problems of Functional Materials • The ability to establish positive interpersonal relationships in an international team
Transversal competencies	• Analysis, interpretation and communication of scientific information and comply with professional ethics and moral values • Planning, monitoring and assuming professional duties of underline group. Proving the coordination capabilities, analytical thinking, adaptability and flexibility, teamwork abilities • Self-evaluation of professional performances and establish the needs of continuous learning, documentation in the work fields in correlation to the labour market

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• Familiarize master students with the basic notions, concepts and techniques used in the synthesis, identification, morpho-structural characterization and potential applications of Functional Materials
7.2 Specific objective of the discipline	• Training skills for dealing with experimental aspects (high-temperature synthesis of solids, synthesis via chemical transport reaction, hydrolytic and non-hydrolytic sol-gel process, hydrothermal process, microwave assisted synthesis, Metal Organic Vapor Deposition process), characterization (e.g. BET analysis, IR spectroscopy, UV-Vis spectroscopy and X-ray diffraction) and potential application (sensors, actuators, medical devices) of various Functional Materials

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction (including introduction of lecturers). Phase, phase diagram, solid state reaction *vs* reaction in solution	Presentation; Explanation	1 hour
2-6. Crystal chemistry I-V	Presentation; Explanation	5 hours
7. Perowskites – structures, polymorphismn, ferroelectricity	Presentation; Explanation	1 hour

[1] One can choose either competences or learning outcomes, or both. If only one option is chosen, the row related to the other option will be deleted, and the kept one will be numbered 6.

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8. Hybrid perowskites – structures, perowskites for solar cells	Presentation; Explanation	1 hour
9. Spinel – structures, magnetism	Presentation; Explanation	1 hour
10. Polymorphism – polymorphs, phase transition	Presentation; Explanation	1 hour
11. Coordination polymers I – building blocks, including organometallic linkers and nodes	Presentation; Explanation	1 hour
12. Coordination polymers II – synthesis strategies	Presentation; Explanation	1 hour
13. MOFs – MOFs and related materials; applications	Presentation; Explanation	1 hour
14. 2D-materials I – graphenes (introduction, fundamental research)	Presentation; Explanation	1 hour
15. 2D-materials II – graphenes (production, characterization and applications of graphene and graphene-based materials, including environment aspects)	Presentation; Explanation	1 hour
16-19. Synthetic methods I-IV	Presentation; Explanation	4 hours
20-21. Sol-gel process I-II	Presentation; Explanation	2 hours
22. Twin polymerisation	Presentation; Explanation	1 hour
23-26. Photocatalysis I-IV	Presentation; Explanation	4 hours
27. Nanocatalysis I – introduction; transition metal nanoparticles in catalysis (size, structure, surface composition)	Presentation; Explanation	1 hour
28. Nanocatalysis II – applications; case studies	Presentation; Explanation	1 hour

Bibliography

1. Course support notes (pdf) and videos – made available by course coordinator
2. A. R. West, *Solid State Chemistry and its Applications - Student Edition*, 2nd Ed., JohnWiley& Sons, Ltd, Chichester (UK), **2014**.
3. U. Schubert, N. Hüsing, *Synthesis of Inorganic Materials*, 4th Ed., Wiley-VCH, Weinheim (Germany), **2019**.
4. S. Kaskel (Ed), *The Chemistry of Metal–Organic Frameworks - Synthesis, Characterization and Applications* (2 vols.), Wiley-VCH, Weinheim (Germany), **2016**.
5. O. M. Yaghi, M. J. Kalmutzki, C. S. Diercks, *Introduction to Reticular Chemistry - Metal-Organic Frameworks and Covalent Organic Frameworks*, Wiley-VCH, Weinheim (Germany), **2019**.
6. S. R. Batten, S. M. Neville, D. R. Turner, *Coordination Polymers - Design, Analysis and Application*, RSC Publishing, Cambridge (UK), **2009**.
7. O. L. Ortiz, L. D. Ramirez (Eds), *Coordination Polymers and Metal Organic Frameworks - Properties, Types and Applications*, Nova Science Publishers, New York (USA), **2012**.
8. E. Hey-Hawkins, M. Hissler, *Smart Inorganic Polymers - Synthesis, Properties, and Emerging Applications in Materials and Life Sciences*,Wiley-VCH, Weinheim (Germany), **2019**.
9. A. C. Ferrari, *et al.*, *Science and Technology Roadmap for Graphene, Related Two-Dimensional Crystals, and Hybrid Systems (Review Article)*, *Nanoscale,* **2015**, *7*, 4598–4810.
10. P. Serp, K. Philippot (Eds), *Nanomaterials in Catalysis,* Wiley-VCH, Weinheim (Germany), **2012**.
11. Reviews and articles from recent scientific literature (ACS, Wiley, Elsevier, RCS, etc.).

8.2 Seminar (on-line) - organized in 2 blocks of 4 and 2 blocks of 3 hours, respectively	Teaching methods	Remarks
1. Block seminar I - crystal chemistry; perowskites; hybrid perowskites; spinel; polymorphism (one topic of each)	Conversation; Learning by discovery; Problem solving	block of 4 hours – 5 seminar topics
2. Block seminar II - coordination polymers (2 topics); MOFs (2 topics); 2D-materials – graphenes (3 topics)	Conversation; Learning by discovery; Problem solving	block of 4 hours – 7 seminar topics

3. Block seminar III - synthetic methods (2 topics); sol-gel process (1 topic); twin polymerization (1 topic)	Conversation; Learning by discovery; Problem solving	block of 3 hours – 4 seminar topics
4. Block seminar IV - photocatalysis (1 topic); nanocatalysis (3 topics)	Conversation; Learning by discovery; Problem solving	block of 3 hours – 4 seminar topics
Bibliography 1. Course support notes (pdf) and recorded lectures – made available by course coordinators. 2. Reviews and scientific articles at choice, but no older than 2020 (from ACS, Wiley, Elsevier, RCS journals, etc.).		
8.3 Practical work (on line) – organized by TUC	Teaching methods	Remarks
1. Photocatalytic degradation of a dye solution	Experiments; Learning by discovery; Interpretation of analytical data	1 hour
2. Synthesis of Bi_2WO_6: solid state reaction	Experiments; Learning by discovery; Interpretation of analytical data	1 hour
3. Synthesis of Bi_2WO_6: Sol gel process	Experiments; Learning by discovery; Interpretation of analytical data	1 hour
4. Synthesis of Bi_2WO_6: hydrothermal synthesis	Experiments; Learning by discovery; Interpretation of analytical data	1 hour
5. Spray coating of Bi_2WO_6 via air brush technique	Experiments; Learning by discovery; Interpretation of analytical data	1 hour
6. Synthesis of Bi_2WO_6: microwave assisted synthesis	Experiments; Learning by discovery; Interpretation of analytical data	1 hour
7. Discussion of practical work and analytical data	Experiments; Learning by discovery; Interpretation of analytical data	8 hours
Bibliography 1. Laboratory support notes (pdf) and videos – made available by course coordinators. 2. G. E. J. Poinern, *A Laboratory Course in Nanoscience and Nanotechnology*, Taylor and Francis Group, ISBN: 1482231034, **2014**.		

9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- By acquiring theoretical / methodological concepts and practical aspects included in *Functional Materials* course, master students acquire a significant amount of knowledge, in accordance with required competencies from Diploma supplement and ANC's qualifications

10. Evaluation

Activity type	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	Correctness of answers – proper understanding and learning of notions and concepts discussed during lectures; correct use of learned concept within new contexts.	Oral / written examination. Proven or intended fraud is punished according to the ECST rules of BBU	50%

	Correct solving of the problems as part of the examination subjects		
10.5 Seminar	Quality of the presentation and discussion of the topic	On-line presentation	25%
10.6 Practical course	Correct interpretation of analytical data and discussion	Laboratory report - delivered at the end of the practical course	25 %
10.7 Minimum standard of performance			
• Grade 5 (five) at the oral exam, participation to the final oral exam is conditioned by participation to all practical courses and seminars and minimum grade 5(five) for these two activities • Adequate knowledge and usage of basic concepts on synthesis, identification, morpho-structural characterization and potential applications of Functional Materials			

11. Labels ODD (Sustainable Development Goals)[2]

	General label for Sustainable Development							
4 EDUCAȚIE DE CALITATE	12 CONSUM ȘI PRODUCȚIE RESPONSABILE							

Date:
31.03.2025

Signature of course coordinator
Acad. Prof. Dr. Cristian Silvestru

Signature of seminar coordinator
Lect. Dr. Eng. Lucian-Cristian Pop

Lector Dr. Ionuț-Tudor Moraru

Date of approval:
15.04.2025

Signature of the head of department
Prof. Dr. Habil. Ing. Monica Toșa

[2] Keep only the labels that, according to the *Procedure for applying ODD labels in the academic process*, suit the discipline and delete the others, including the general one for *Sustainable Development* – if not applicable. If no label describes the discipline, delete them all and write „*Not applicable*.".