National University of Science and Technology
Politehnica Bucharest

Faculty of Engineering in Foreign Languages

Master program: Advanced Materials Processing and Design in ENGLISH LANGUAGE, 2024-2026

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CONTENT OF THE LECTURES FROM THE STUDY PLAN

Ist YEAR

I Year, 1st Semester

Cod disciplina	F/D/ S/C	An	Sem	Denumire disciplina	E/V	C	S	L	P	Credite
UPB.12.M1.013-11	DF	1	1	**Advanced methods of synthesis of substances and materials**	E	2		2		**5**
UPB.12.M1.O.13-12	DD	1	1	**Advanced Methods of Surfaces and Interfaces Functionalization**	E	2		1		**5**
UPB.12.M1.O.13-13	DD	1	1	**Correlations of composition – synthesis – processing – properties in term of functions of use of materials**	E	2		2		**5**
UPB.12.M1.O.13-14	DD	1	1	**CAD of Materials with Predetermined Morpho-Structural Features**	V	2		1	2	**5**
UPB.12.M1.O.13-15	DD	1	1	**Scientific Research**	V					**10**
Pachet Facultative (2024-2025)										
UPB. 12.M1.F.13-16	DC			How to prepare a scientific work / Autorat Stiintific	V		2			2

UPB. 12.M1.F.13-17	DC			The design and management of the educational programs / Proiectarea și managementul programelor educaționale	E	2	1			5

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Advanced methods of synthesis of substances and materials- Teacher: Mihai EFTIMIE

The course is structured so that Master's student can acquire knowledge, needed to correlate the theoretical basis of the development of the synthesis method with the proposed synthesis reactions and the types of products synthesized by the advanced synthesis method taking into account the description of the main reactions underlying the proposed advanced synthesis, advantages and disadvantages of using the advanced synthesis method, and the impact assessment of material properties on targeted application and performances.

Advanced Methods of Surfaces and Interfaces Functionalization - Teachers: Denisa FICAI

The Advanced Methods of Surfaces and Interfaces Functionalization course, is mainly devoted to highlight the influence of the surfaces and interfaces in the development of materials for specific applications. Chemical, physical or complex surface modification techniques will be considered but, the course will be focused especially on chemical surface modification knowing that covalent modification is beneficial and can last for a long period of time. Considering the nature of the substrate but also the moieties which are introduced on the surface, new or improved properties can be obtained and these materials can be suitable for civil or military applications, biomedical or environmental applications, energy, etc.

Correlations of composition – synthesis – processing – properties in term of functions of use of materials – Teachers: Ecaterina ANDRONESCU

The course delves into the correlations between composition, synthesis parameters, processing conditions and properties in terms of the function use of materials. It emphasizes the classification of composite materials and the design strategies to obtain them. Mechanical properties, optical properties, electronic properties and magnetic properties are correlated with the composition and synthesis/processing parameters

as well as with the size effects. Besides, it includes key notions of special nanostructured materials, composites based on carbonaceous materials, porous composites and nanobiocomposites. The topics followed in the course will enable students to gain knowledge of trends in the nano and microcomposites chemistry for various applications and will enable them to process experimental data in real-time.

CAD of Materials with Predetermined Morpho-Structural Features – Teacher: Zeno GHIZDAVET

CAD of Materials with Predetermined Morpho-Structural Features aims to provide students with both basic and advanced knowledge regarding the design of complex-shaped structures that are used as a support in recuperative medicine. The major feature of the course is its applicability; therefore, the theoretical part will be subsequent to the main goal. After creating the structure, design analysis of the model - in terms of mass and porosity - will help students to select the optimal design that is able to guarantee both cell proliferation and the appropriate mechanical strength. Ultimately, students will be able to confidently create designs with predetermined morpho-structural features.

Scientific Research - Teacher: any of the teaching staff of the program

The “Scientific Research” from the first semester is mainly focused on the identification of the research topic and for a literature review mainly devoted to clearly assess the state of the art in the field and furthermore to establish the objectives and the major activities which will be consider in the forthcoming steps. The MSc students will choose their research topic and scientific advisor considering the proposed research topics available (provided by the teachers involved in this program) or by direct discussions with the teachers. As an important deliverable of this discipline, along with the working plan, a preliminary literature review will be delivered which will represent the literature part of the MSc thesis.

How to prepare a scientific work - Teacher: Mihai EFTIMIE

The communication in the field of science and technology but especially in academic activity is significant worldwide. This course is designed to offer to the master students the basic knowledges to be able to disseminate original or secondary data. This is important for the epistemic community and especially to the absolvents working in the academic / teaching field but also for those working in SMEs, in this way they are being able to better promote their materials, services, technologies, etc. Ethical issues are also of

increasing importance at national but also international level so an introduction in the field is welcome to teach the students to prepare high quality posters, oral presentations, original papers/letters or patent applications (both administrative and scientific parts).

I Year, 2nd Semester

Cod disciplina	F/D/ S/C	An	Sem	Denumire disciplina	E / V	C	S	L	P	Credite
UPB.12.M2.O.13-21	DD	1	2	**Multifunctional and smart oxide materials**	E	2				**4**
UPB.12.M2.O.13-22	DS	1	2	**Advanced manufacturing techniques of 3D materials**	E	2		2		**5**
UPB.12.M2.O.13-23	DS	1	2	**Advanced manufacturing techniques of 2D materials**	E	2		2		**5**
UPB.12.M2.O.13-24	DS	1	2	**Advanced manufacturing techniques of 1D materials**	V	2		1		**3**
UPB.12.M2.O.13-25	DS	1	2	**Advanced manufacturing techniques of 0D materials**	E	2		1		**3**
UPB.12.M2.O.13-26	DD	1	2	**Scientific Research**	V					**10**

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Multifunctional and smart oxide materials –Teacher: Adelina-Carmen IANCULESCU

This discipline "Multifunctional and smart oxide materials" is studied within the specialization Processing and Design of Advanced Materials related to the field of Chemical Engineering. In order to fulfill some requirements imposed by the current context of miniaturization and the high degree of integrability in advanced fields, such as micro-/nano-electronics and opto-electronics, this course aims to provide general notions specific to the field of advanced materials, related to compositional design, crystal structure, defect chemistry, microstructure/texture, functional

properties, with a determining role for the use of the multifunctional and smart oxide materials. The course focuses on familiarize students with aspects related to the identification, description and use of concepts related to: (*i*) oxide systems with appropriate purity levels for obtaining multifunctional and smart oxide materials; (*ii*) non-conventional processing methods to produce zero-, one-, two- and three-dimensional nano-entities, as well as submicron- and nano-structured materials related to the multifunctional and smart oxide systems and (*iii*) correlation of the processing parameters with the compositional design in order to elaborate smart materials with targeted properties.

Advanced manufacturing techniques of 3D materials: Alexandru Mihai GRUMEZESCU

The course "Advanced manufacturing techniques of 3D materials" covers various topics essential for understanding and innovating in 3D materials engineering. The lecture content begins with an introduction to the fundamental concepts, nomenclature, and classification systems pertinent to 3D materials. It then delves into advanced 3D fabrication techniques, including in-depth discussions on 3D printing, template creation, and scaffold structures. The course also explores the latest developments in 3D hardware and software modeling, culminating in an overview of various applications of 3D materials. Each topic is meticulously designed to provide students with a robust theoretical framework that supports their understanding of the complex processes involved in 3D fabrication.

The laboratory sessions complement the theoretical aspects by providing practical, hands-on experience. Students are introduced to laboratory safety, workflow, and assessment methods before using advanced techniques for preparing organic, inorganic, and composite 3D scaffolds. These sessions include detailed work with 3D modeling software and hardware, ensuring students learn to use the tools and techniques required for 3D materials fabrication. By bridging the gap between theory and practice, the laboratory component ensures that students can apply their knowledge effectively, fostering innovation and skill development in real-world scenarios.

Advanced manufacturing techniques of 2D materials - Teacher: Anton FICAI

The overall objective of the course is to introduce the students in the field of 2D materials. For this purpose, the transmission of knowledge (both theoretical and practical) as well as the innovative thinking will be used in order to solve some challenges from the biomedical, environmental, energy or electronic field. This

course will provide the necessary knowledges to identify the proper coatings and processing routes to obtain desired properties and functionalities. The course "Advanced manufacturing techniques of 2D materials" covers various topics essential for understanding the role of the 2D structuration with direct impact in the properties and potential applications as well as the methods which can be used to develop such materials, etc. The most important techniques of synthesis and processing will be presented including film casting, Langmuir-Blodget technique for developing (self-)assembled layers; spin and deep-coating, electrospinning, some electrochemical deposition techniques as well as other physico-chemical methods such as sputtering, CVD, PLD, MAPLE, etc.

Advanced manufacturing techniques of 1D materials - Teacher: Anton FICAI

The general objective of the course "**Advanced manufacturing techniques of 1D materials**" is to focus on one-dimensional (1D) nanostructures – wires, rods, whiskers, belts, and tubes – whose lateral dimensions fall anywhere in the range of 1 to 100 nm. The main attention will be focused on synthetic strategies that have been exploited to achieve 1D growth. Understanding the role of synthesis, characterization and applications of 1D nanostructured materials will be identified and emphasized the advantages / limitations of the present techniques and future improvements, as well. Among the 1D synthesis/processing methods, the following methods will be discussed in details: electrospinning, different physical and chemical deposition methods, template assisted methods, etc. Certainly the role of the 1D structuration and their specific applications will be considered. A special attention will be paid for the development of the laboratory skils of the students, from design to synthesis, processing, characterisation and testing the performances of these materials according to the desired final applications.

Advanced manufacturing techniques of 0D materials – Teachers: Ecaterina ANDRONESCU

The overall objective of the course is to enable students to gain theoretical and pratical understanding of 0D nanomaterials and their synthetic routes via physical or chemical approaches. The syllabus of the course encompasses: the classification of 0D nanomaterials, synthesis of 0D nanostructured materials by physical processes, synthesis of 0D nanostructured materials by chemical processes and applications of 0D

nanomaterials. The topics collectively provide students the knowledge of trends in 0D nanomaterials manufacturing and the capacities of using modern theories and synthetic methods.

Scientific Research - Teacher: any of the teaching staff of the program

The "Scientific Research" from the second semester is mainly focused on the starting the implementation of the work plan. The work plan is expected to be continuously updated by on the evolution of the research and the obtained results. The synthesis strategies will be selected considering more options available in the literature and also new approaches will be considered in improving the properties of the materials.

IInd YEAR

IInd Year, 1st Semester

Cod disciplina	F/D/ S/C	An	Sem	Denumire disciplina	E/V	C	S	L	P	Credite
UPB.12.M3.O.13-31	DD	2	1	**Advanced microscopy techniques**	E	2		1		**4**
UPB.12.M3.O.13-32	DD	2	1	**Advanced Techniques of Spectrometric Analysis**	E	2		1		**4**
UPB.12.M3.O.13-33	DD	2	1	**X-Ray Diffraction and Fluorescence**	E	2		1		**3**
UPB.12.M3.O.13-34	DD	2	1	**Complex thermal analysis**	E	2		1		**4**
UPB.12.M3.O.13-35	DS	2	1	**Design and manufacturing of materials with special applications**	V	0			2	**3**
UPB.12.M3.O.13-36	DS	2	1	**Standards for testing and certification of materials in terms of targeted application/ evaluation of their performance**	V	1		1		**2**

UPB.12.M3.O.13-37	DD	2	1	**Scientific Research**	V					**10**

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Advanced Microscopy Techniques – Teachers Bogdan Stefan VASILE

These courses collectively equip individuals with a comprehensive skill set in electron microscopy, from fundamental principles to advanced analytical techniques, ensuring proficiency in both practical and theoretical aspects of microscopy analysis: Atomic Force Microscopy (AFM); Scanning Electron Microscopy (SEM); Transmission Electron Microscopy (TEM**)**. A special attention is also payd for the Sample Preparation Techniques for Microscopy Analysis but also to the Specific Investigation Methods in Electron Microscopy and for the Interpretation of the Results. Collectively, these courses provide a comprehensive education in electron microscopy, ensuring that students are well-versed in both practical and theoretical aspects. Graduates will emerge with the competence to conduct advanced microscopy analysis and the skills to contribute meaningfully to research and industry.

Advanced Techniques of Spectrometric Analysis - Teacher: Dan Eduard MIHAIESCU

Advanced Techniques of Spectrometric Analysis course is mainly focused to highlight the importance and advantages of the modern spectrometric tools in organic/inorganic nanomaterials characterization, and to develop the basic practical abilities in spectrometry. The following techniques: FT-IR, Raman, UV-VIS, MS, NMR and ICP-OES/MS spectrometry will be especially developed from the understanding of the basic concepts to qualitative and quantitative assessments and finaly to discuss advanced applications in various fields.

X-ray diffraction and X-ray Fluorescence – Teacher: Vasile-Adrian SURDU

The course highlights the role of X-ray based techniques on the characterization and manufacturing control of materials in the framework of advanced materials processing. The syllabus includes topics such as

concept of crystalline state, X-ray diffraction instrumentation and theory of diffraction, experimental techniques in X-ray diffraction, data processing and phase analysis in X-ray diffraction, quantitative methods in X-ray powder diffraction, X-ray Fluorescence instrumentation, qualitative and quantitative analysis by X-ray spectrometry. Through its content, the course aims to transfer knowledge to students about the characterization of advanced materials in terms of structural, micro and nanostructural, and chemical composition as well as to form skills related to determining or verifying the main required structural and compositional features of materials.

Complex thermal analysis - Teacher: Ovidiu OPREA

The course aims to present the basics of the thermal analysis needed in training the future chemist engineer. The course will provide students with the knowledge necessary for the understanding and interpretation of thermal analysis and help make correlation between results and other probable properties. Thermal analysis is a physico-chemical method of investigating the structure, composition and properties of a sample. Among others students will learn specific options to the operation mode (sample support, crucibles, atmosphere types, thermal regime etc) with advantages and disadvantages. By coupling the thermal analyzer with other instruments (GC-MS or FTIR), new, richer information can be obtained on the analyzed sample. By this coupling the gaseous products resulting from the thermal analysis are identified, the main purpose of the course being the presentation of the correlations and the way of interpretation of the obtained results.

Design and manufacturing of materials with special applications - Teacher: Alina MELINESCU

This project, Design and manufacturing of materials with special applications, is offered within the Advanced Materials Processing and Design master program, with the major aim to develop the necesary knowledges and skils to became an independent researcher, to highlight the necesary steps to pass from an idea to a final materials, with proper characteristics and performances. A special atention will be paid to the documentation part, to synthesis and processing,

characterisation and evaluation and finally to decide which precursors, synthesis routes and methodology are the most suitable for the scope.

Standards for testing and certification of materials in terms of targeted application/evaluation of their performanc - Teacher: Mihai EFTIMIE

The course brings the correlation between the concepts of testing and certificate a material. Theoretical and practical competences will enable student's work in fair conditions in research and testing laboratories, and in some industrial areas that use standards to evaluate and conform products and materials, considering the standards and their role in a global market ant the need for knowledge on the test methods used for advanced materials to certificate them.

Scientific Research - Teacher: any of the teaching staff of the program

The "Scientific Research" from the third semester is mainly focused on the implementation of the work plan. The work plan is expected to be continuously updated by on the evolution of the research and the obtained results. Characterisation techniques will be used in order to understand the evolution of the work plan implementation and also for the final evaluation of the materials.

IInd Year, IInd Semester

Cod disciplina	F/D/ S/C	An	Sem	Denumire disciplina	E/V	C	S	L	P	Credite
UPB.12.M4.O.13-41	DC	2	2	**Ethics and academic Integrity**	E	1				**2**
UPB.12.M4.O.13-42	DS	2	2	**Research practice for MSc thesis preparation**	V					**10**
UPB.12.M4.O.13-43	DS	2	2	**Scientific Research, research practice and MSc thesis preparation**	V					**10**

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Ethics and Academic Integrity - Teachers:

The course Ethics and Academic Integrity aims to develop ethical research skills but also associated with the dissemination of the results by publishing articles and delivering conference presentations. The course is based on a theoretical part mainly related to the understanding the info, and a more applicative one, mainly based on case studies and examples. At the end of this course, the students have to be able to identify and to avoid to be involved in ethical and integrity-related issues in various branches of research.

Research practice for MSc thesis preparation - Teachers: any of the teaching staff of the program

The master program "Advanced Materials Processing and Design" is a research program with many activities devoted to advanced research. The MSc thesis is a research-based thesis and this is why consistent time is allocated. In this semester, the research activities are finished by optimisations and final characterization of the materials and systems.

Scientific Research, research practice and MSc thesis preparation - Teacher: any of the teaching staff of the program

Considering that the master program "Advanced Materials Processing and Design" already allocated 2h for a facultative course "How to prepare a scientific work" and also in the "Ethics and academic Integrity" course also some elements related to the writing of original works were mentioned, the MSc thesis preparation should be done easily considering the accumulated scientific knowledges. The MSc thesis will be realized according to the general rules and in collaboration with the standards imposed by the supervisor.