Curriculum for the Joint-Degree Master's Program in Science and Technology of Materials at the Paris Lodron University Salzburg and the Technical University of Munich - Curriculum 2024

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Contents

The Senate of Paris Lodron University Salzburg, by resolution dated 12 March 2024, has adopted the curriculum for the English-language Joint-Degree Master's Program in Science and Technology of Materials as decided by the Curriculum Committee for the Bachelor's Program in Materials and Sustainability, Joint-Degree Bachelor's Program in Engineering, Master's Program in Chemistry and Physics of Materials, and Joint-Degree Master's Program in Science and Technology of Materials of the University of Salzburg in its meeting on 3 April 2024.

The legal basis is the Federal Act on the Organization of Universities and their Studies (Universities Act 2002 – UG), BGBl. I No. 120/2002, as well as the study law section of the statutes of the University of Salzburg in their current version.

§ 1 General Information

1. The total scope of the Joint-Degree Master's Program in Science and Technology of Materials is 120 ECTS credits. This corresponds to a planned study duration of 4 semesters.
2. Graduates of the Joint-Degree Master's Program in Science and Technology of Materials are awarded the academic degree "Master of Science," abbreviated "MSc."
3. The prerequisite for admission to the Joint-Degree Master's Program in Science and Technology of Materials is the completion of a relevant Bachelor's program or another relevant study program of at least the same level of higher education at a recognized domestic or foreign post-secondary educational institution (see § 64 Abs. 3 UG).
4. To compensate for significant subject-specific differences, additional performance records of up to 45 ECTS credits may be required, which must be completed by the end of the second semester of the Master's program. The determination of whether significant subject-specific differences exist is the responsibility of the Rectorate or a person appointed by it at the University of Salzburg.
5. All performance records to be completed by students are allocated ECTS credits. One ECTS credit corresponds to 25 working hours at PLUS and 30 working hours at TUM and describes the average workload required to achieve the expected learning outcomes. The workload of an academic year corresponds to 1500 to 1800 real hours and thus an allocation of 60 ECTS credits.
6. Students with disabilities and/or chronic illnesses must not experience any disadvantages in their studies. The principles of the UN Convention on the Rights of Persons with Disabilities, the Federal Equal Treatment Act, and the principle of disadvantage compensation apply.

§ 2 Subject of Study and Qualification Profile

1) Subject of Study
   Innovative applications and fields of activity in science, technology, and medicine, including their industrial use, require novel materials whose performance spectrum

differs from previous material concepts.

Examples of goals and challenges of existing key technologies include increasing the energy efficiency of materials (mechanical engineering, energy and environmental technology, and IT), the sustainable extraction of bio-based raw materials (bioeconomy), or the design of bioactive surfaces, such as for medical implants (medical technology). To address these challenges, synergies between different scientific and technical disciplines are increasingly being used. Since mastering current challenges in every field of technology is only possible with a good knowledge, selection, and characterization of the materials in question, there is a continuous demand for well-trained materials scientists and engineers.

The Joint-Degree Master's Program in Science and Technology of Materials is offered as a joint degree between Paris Lodron University Salzburg (PLUS) and Technical University of Munich (TUM). It is an interdisciplinary program focused on the production, characterization (description of material and function), and knowledge-based further development (processing) of structural and functional materials in the laboratory and in application. Regarding the intended material functions, it is the chemical, physical, and, in many cases, biological factors that determine a material's properties, stability, and environmental compatibility. The current challenges in material development still lie in improving material properties and realizing more meaningful constructions aimed at reducing the ratio of material quantity to technical effect. The gain in functionality compared to the absolute amounts of produced materials thus comes to the fore, while the shares of critical raw materials should not increase. The overall goal of the program is to train scientists and engineers for the aforementioned challenges and their application in material production and characterization, material development, construction, simulation, and production. Additionally, the program builds on the growing awareness of the importance of material cycles and resource efficiencies. Cross-disciplinary approaches to achieving these goals are to be conveyed in this program.

2) Qualification Profile and Competencies (Learning Outcomes)

The program provides insights into current methods of material production and characterization and introduces a wide range of technical applications. At TUM, further studies will focus on the materials concerning their use in a technical application. In particular, materials will be analyzed in terms of their stability under application conditions as a function of various operating modes (e.g., pressure, temperature, fields, moisture). This is complemented by the life cycle analysis of the material under different usage conditions. Students will also expand their knowledge of the application fields and the associated trends for various materials.

In terms of subject knowledge, the program initially expands knowledge in the disciplines of chemistry, physics, and materials science at the master's level.

Furthermore, knowledge in materials engineering and mineral or biogenic materials is enhanced. Building on this, the School of Engineering and Design offers a series of foundational (e.g., materials development) and/or production-oriented (e.g., manufacturing technologies) modules as the technical application-oriented engineering component of the study program.

Under these aspects, graduates of the program possess the following subject competencies: they can produce a desired material (product) with defined properties. They apply state-of-the-art analytical methods that enable them to understand and optimize the structure-property relationships of materials in connection with the process parameters during their production. This enables them to assess and evaluate the performance of a material regarding its application profile, allowing it to be used economically and sustainably. Moreover, students are enabled to develop a novel material and material design that follows the principle of "reduce, reuse, and recycle."

Students are familiar with the latest methods of production, processing, and characterization of structural and functional materials, know current fields of application and trends, and can conduct both basic and applied research in these areas. They are thus capable of working independently in scientific settings and can develop innovative material and process-related solutions for sustainable developments. In particular, they have a good overview of current natural and engineering scientific research methods and can develop research strategies for basic and applied scientific projects and carry them out independently.

3) Need and Relevance of the Study Program for Science, Society, and the Job Market

The development of innovative and competitive products is considered a central cross-sectoral goal in all engineering disciplines and many natural sciences. At the same time, the development of novel multifunctional materials and material composites opens up great potential for lighter, more energy-efficient, safer, environmentally friendly, and sustainable construction methods. Detailed knowledge about materials in terms of synthesis, structure, properties, their characterization, their behavior in use, and their reintegration into the material cycle is of central importance now and in the future. Without them, innovations in the aforementioned application areas are not possible, nor can the societal challenges addressed be satisfactorily resolved with the existing materials.

Equipped with the aforementioned competencies, graduates of the interdisciplinary study program bring about synergies between different scientific and technical disciplines. Therefore, a particularly wide range of career fields is open to them, ranging from specific professional activities to roles in service sectors and management.

Graduates of the Joint-Degree Master’s Program in Science and Technology of Materials have career opportunities in:

- the automotive and aerospace industries
- environmental engineering
- the chemical industry and construction
- biotechnology and medical technology
- the electrical and electronics industries
- research at universities and non-university scientific institutes
- generally in materials development and production technology.

§ 3 Structure and Organization of the Study Program

The study locations are Salzburg (PLUS) as well as Garching/Munich (TUM-School for Engineering and Design, Department for Materials Engineering) or Straubing (TUM-Campus Straubing for Biotechnology and Sustainability). Due to the spatial distance between Munich and Straubing, students at TUM are recommended to take all courses of a semester exclusively at one study location according to the focal points offered there. The subject focus also means a local focus.

Applications for the program are submitted exclusively to the University of Salzburg (PLUS), where the admission process, involving members of TUM, is conducted. The program can only be started in the winter semester at either of the two universities. There are two possible variants for the study program sequence:

Semester	**Variant A**	**Variant B**
I	PLUS	TUM
II	PLUS	TUM
III	TUM	PLUS
IV	Master's Thesis	Master's Thesis

The Joint-Degree Master's Program in Science and Technology of Materials includes 11 modules (Variant A) or 7 PLUS modules/TUM focus modules (Variant B) for which 120 ECTS credits are allocated. Additionally, 12 (Variant A) or 6 (Variant B) ECTS credits are allocated for free elective courses. The master's thesis is awarded 27 ECTS credits.

	ECTS	
	Variant A	Variant B
Chemistry of Materials A	5	5
Chemistry of Materials B	5	
Physics of Materials	5	5
Materials Characterization A	4	4
Materials Characterization B	9	
Profiling modules		
Advanced Topics in Materials Science A	10	10
Advanced Topics in Materials Science B	10	

Focus Module TUM A	30	30
Focus Module TUM B		30
Free Elective Courses	12	6
Seminar Materials Science	1	1
Master's thesis	27	27
Master's examination	2	2
Sum	**120**	**120**

§ 4 Types of Courses

The program includes the following types of courses:

- **Lecture (VO)** provides an overview of a subject or one of its subfields and its theoretical approaches and presents different teaching opinions and methods. The content is mainly delivered in lecture style. A lecture is not examination-immanent and does not require attendance.
- **Lecture with exercise (VU)** combines theoretical introduction to a subfield with the acquisition of practical skills. A lecture with exercise is not examination-immanent and does not require attendance.
- **Seminar (SE)** is an advanced scientific course. It serves to acquire in-depth knowledge and to discuss and reflect on scientific topics through active participation by students. A seminar is an examination-immanent course with compulsory attendance.
- **Internship (PR)** serves the application and consolidation of learned knowledge and methods and the acquisition of practical skills. An internship is an examination-immanent course with compulsory attendance.

§ 5 Study Content and Course Progression

The following lists the modules and courses of the Joint-Degree Master's Program in Science and Technology of Materials. The assignment to semesters is a recommendation and ensures that the sequence of courses builds optimally on prior knowledge and that the annual workload does not exceed 60 ECTS credits. Modules and courses can also be completed in a different order. Detailed descriptions of the modules, including the knowledge, methods, and skills to be taught, can be found in Appendix I: Module Descriptions.

Variant A: Starting the Program in the Winter Semester at PLUS

Joint-Degree Master's Program in Science and Technology of Materials

Module	Course	SSt.	Type	ECTS	Semester with ECTS			
I								
(1) Compulsory Modules								
STM 01: Chemistry of Materials A								
	STM 01.1 Chemistry of Materials I	3	VO	3	3			
	STM 01.2 Chemistry of Materials I	2	VU	2	2			
	Subtotal Module STM 01	5		5	5			
STM 02: Physics of Materials								
	STM 02.1 Physics of Materials	3	VO	3	3			
	STM 02.2 Functional Materials	2	VO	2	2			
	Subtotal Module STM 02	5		5	5			
STM 03: Materials Characterization A								
	STM 03.1 Materials Characterization I (Scattering and Diffraction)	3	VU	4	4			
	Subtotal Module STM 03	3		4	4			
STM 04: Chemistry of Materials B								
	STM 04.1 Chemistry of Materials II	2	VO	2		2		
	STM 04.2 Materials Selection	2	VU	3		3		
	Subtotal Module STM 04	4		5		5		
STM 05: Materials Characterization B								
	STM 05.1 Materials Characterization II (Microscopy)	2	VU	3			3	
	STM 05.2 Materials Characterization III (Thermophysical Properties & Thermal Analysis)	2	VO	2		2		
	STM 05.3 Materials Characterization IV (Elemental Analysis and Spectroscopy)	3	VU	4		4		
	Subtotal Module STM 05	7		9		9		

Total Compulsory Modules	24	28	14	14

(2) Profiling and Focus Modules according to § 6

Profiling Modules at PLUS

(Indicated are the ECTS units to be completed per profiling module. To fulfill them, the courses from the list of courses under § 6 for each profiling module can be freely chosen.)

Module	Course	SSt.	Type	ECTS	Semester with ECTS	
STM WM 07: Advanced Topics in Materials Science A				10	10	
STM WM 08: Advanced Topics in Materials Science B				10		
Total Profiling Modules - PLUS				20	10	

Focus Module at TUM (Campus Garching or Campus Straubing)

(Indicated are the ECTS units to be completed per focus module. A suitable selection of TUM elective modules and appropriate supplementary modules and internships can focus on various priorities, see § 6)

Module	Course	SSt.	Type	ECTS	Semester with ECTS	
TUM Focus Module A				30		
Total Focus Modules - TUM				30		
Total Profiling and Focus Modules				50	10	

(3) Free Elective Courses

Course	SSt.	Type	ECTS	Semester with ECTS
12	6			

(4) Seminar Materials Science

Course	SSt.	Type	ECTS	Semester with ECTS
1		SE	1	

(5) Master's Thesis

Course	SSt.	Type	ECTS	Semester with ECTS
	27			

(6) Master's Examination

Course	SSt.	Type	ECTS	Semester with ECTS
	2			
Total				

Course	SSt.	Type	ECTS	Semester with ECTS
	120		30	

Variant B: Starting the Program in the Winter Semester at TUM

Joint-Degree Master's Program in Science and Technology of Materials

Module	Course	SSt.	Type	ECTS	Semester with ECTS
I					
	(1) Compulsory Modules				
	STM 01: Chemistry of Materials A				
	STM 01.1 Chemistry of Materials I	3	VO	3	
	STM 01.2 Chemistry of Materials I	2	VU	2	
	Subtotal Module STM 01	5		5	
	STM 02: Physics of Materials				
	STM 02.1 Physics of Materials	3	VO	3	
	STM 02.2 Functional Materials	2	VO	2	

Subtotal Module STM 02	5	5			
STM 03: Materials Characterization A					
STM 03.1 Materials Characterization I (Scattering and Diffraction)	3	VU	4		
Subtotal Module STM 03	3	4			
Total Compulsory Modules	13	14			

(2) Profiling and Focus Modules according to § 6

Profiling Modules at PLUS

(Indicated are the ECTS units to be completed per profiling module. To fulfill them, the courses from the list of courses under § 6 for each profiling module can be freely chosen.)

Module	Course	SSt.	Type	ECTS	Semester with ECTS
STM WM 07: Advanced Topics in Materials Science A				10	
Total Profiling Modules - PLUS				10	

Focus Modules at TUM (Campus Garching or Campus Straubing)

(Indicated are the ECTS units to be completed per focus module. A suitable selection of TUM elective modules and appropriate supplementary modules and internships can focus on various priorities, see § 6)

Module	Course	SSt.	Type	ECTS	Semester with ECTS
TUM Focus Module A		30		30	
TUM Focus Module B		30			
Total Focus Modules - TUM				60	30
Total Profiling and Focus Modules				70	30

(3) Free Elective Courses

Course	SSt.	Type	ECTS	Semester with ECTS

(4) Seminar Materials Science

Course	SSt.	Type	ECTS	Semester with ECTS
1	SE		1	

(5) Master's Thesis

Course	SSt.	Type	ECTS	Semester with ECTS
27				

(6) Master's Examination

Course	SSt.	Type	ECTS	Semester with ECTS
2				
Total				

Course	SSt.	Type	ECTS	Semester with ECTS
120	30			

§ 6 Profiling and Specialization Modules

In the Joint-Degree Master's Program in Science and Technology of Materials, profiling and specialization modules with 50 (Variant A) or 70 (Variant B) ECTS credits are to be completed across PLUS and TUM. At PLUS, profiling modules consist of a thematically focused portfolio of courses from which students can choose. Specialization modules at TUM consist of TUM elective modules, complementary modules, and practicals.

PLUS profiling modules and TUM specialization modules serve to specialize and deepen the knowledge in a specific area of personal material science interest. In line with the learning outcomes and contents described in the PLUS profiling modules and TUM specialization modules, courses at the respective study locations are to be chosen.

§ 7 Free Elective Courses

(1) In the Joint-Degree Master's Program in Science and Technology of Materials, free elective courses amounting to 12 (Variant A) or 6 (Variant B) ECTS credits must be completed. These can be freely chosen from the course offerings of all recognized post-secondary educational institutions and serve to acquire additional qualifications and set individual focuses within the study program.
(2) If there is an internal subject-related connection of the chosen courses amounting to 12 ECTS credits, an elective module designation can be made in the master's certificate.
(3) To broaden the educational horizon and support interdisciplinary thinking, other courses from the profiling and specialization modules according to § 6 and other courses from the following knowledge areas are recommended:
- Physics, Chemistry, Material or Materials Science, Geosciences, Biosciences, Environmental Sciences
- Mathematics, Computer Science, Programming, Data Acquisition, Simulation
- Mechanics, Engineering, Mechanical Engineering, Process Engineering
- Electrical Engineering, Control Engineering, Electronics
- Economics, Law
- Gender Studies, Global Studies, Languages, Media, Rhetoric.

§ 8 Master's Thesis

(1) The master's thesis serves to demonstrate the ability to independently address scientific topics from the area of Science and Technology of Materials according to current scientific standards in terms of content and methodology.
(2) The topic of the master's thesis must be chosen so that it can be completed within six months (see § 81 Abs. 2 UG).
(3) Topics for the master's thesis should relate to the scientific and engineering content of the modules defined in § 3 or Appendix I of the curriculum and are coordinated by PLUS. Topic proposals can be submitted by the departments, institutes, and chairs involved in the Joint-Degree Master's Program in Science and Technology of Materials at both universities, as well as by the students themselves. The topic proposals must be sufficiently detailed to allow an examination of the following criteria:
- Relevance to the module contents or curriculum contents
- Fulfillment of general requirements
- Feasibility within the given time frame
- Supervision by university teachers (usually with teaching authorization) from the departments, institutes, and chairs involved in the Joint-Degree Master's Program in Science and Technology of Materials at PLUS or TUM.

Formal approval of the topic chosen by the student is granted by the dean after a statement from the chair of the curriculum committee.

(4) The master's thesis is assessed with 27 ECTS credits.
(5) The copyright law provisions (BGBl. Nr. 111/1936) must be observed when working on the topic and supervising students (see § 80 Abs. 2 UG).
(6) The master's thesis can only be registered after at least 80 percent of the required ECTS credits for compulsory and elective modules and any additional requirements have been completed.
(7) The results of the master's thesis must be presented in a Materials Science seminar.

§ 9 Internship

Students have the opportunity to have a career-oriented internship credited within the framework of the free elective courses amounting to up to 4 weeks of full-time employment (equivalent to a maximum of 6 ECTS credits). The internship must have a meaningful connection to the study program and must be approved by the responsible academic authority at PLUS before the internship begins. For the recognition of this achievement, an internship certificate is required, including the following points: location and department of the institution or company where the internship was completed, duration of the internship, brief description of the activities performed, and a written evaluation by the responsible supervisor.

During the career-oriented internship, the following qualifications can be acquired:
- Application of acquired subject-specific competencies in a professional context
- Familiarization with application scenarios of scientific concepts
- Acquisition of soft skills (e.g., teamwork, communication skills, planning skills) in a professional context.

§ 10 International Mobility

Students of the Joint-Degree Master's Program in Science and Technology of Materials are required to complete at least one semester at the Technical University of Munich (TUM).

Additionally, students of the Joint-Degree Master's Program in Science and Technology of Materials have the opportunity to complete a semester abroad at another foreign university. This is particularly suitable for the second semester of the program. The recognition of courses completed during the study abroad is carried out by the responsible academic authority. The necessary documents for evaluation must be submitted by the applicant.

It is ensured that study abroad semesters are possible without delays in the study progress if the following conditions are met:
- Courses amounting to at least 30 ECTS credits are completed per study abroad semester
- The courses completed during the study abroad do not overlap in content with courses already completed at the University of Salzburg

- Prior to the start of the study abroad semester, it is determined which planned exams will be recognized for required exams in the curriculum.

In addition to subject-specific competencies, the following qualifications can be acquired through a study abroad:
- Acquisition and deepening of subject-specific foreign language skills
- Acquisition and deepening of general foreign language skills (language comprehension, conversation, etc.)
- Acquisition and deepening of organizational skills through independent planning of the study routine in international administrative and university structures
- Familiarization with and studying in international study systems, thereby broadening one's own subject perspective
- Acquisition and deepening of intercultural competencies.

Students with disabilities and/or chronic illnesses are actively supported by the university in finding a place for a study abroad semester and in its planning.

§ 11 Allocation of Places in Courses with Limited Number of Participants

(1) The number of participants in the Joint-Degree Master's Program in Science and Technology of Materials is limited for the following course types at PLUS:

- Lecture (VO): No limitation
- Lecture with Exercise (VU): No limitation
- Practical (PR): 10
- Seminar (SE): No limitation

(2) In courses with a limited number of participants, if the maximum number of participants is exceeded by the number of registrations, those students for whom the course is part of the curriculum are given preference.
(3) The allocation of places is done according to the order specified in the regulations of the University of Salzburg.
(4) For students in international exchange programs, places amounting to at least ten percent of the maximum number of participants are available in addition to the maximum number of participants. These places are allocated by lot.

§ 12 Examination Regulations

The regulations for assessing academic performance, the annulment of assessments, the issuance of certificates, the determination of examination dates, the registration for exams, the conduct, repetition, and recognition of exams, and the legal protection in examinations apply to studies in Salzburg according to the regulations in the academic part of the statutes

of the Paris Lodron University Salzburg (PLUS) and for studies in Munich according to the regulations of the General Examination and Study Reg...

At TUM, the modules of this curriculum are assessed through TUM module examinations. The achievement of module objectives is assessed across all courses of the module (written exam or certificate) and evaluated. For the module examinations at TUM, the regulations of the APSO for Bachelor's and Master's programs at TUM apply.

At PLUS, the modules of this curriculum are assessed through PLUS module examinations or PLUS module partial examinations.

For students with disabilities or chronic/mental illnesses, different examination modalities tailored to the individual case are determined by the Vice Rector for Teaching and Studies in cooperation with the FGDD department.

§ 13 Commissioned Master's Examination

(1) The Joint-Degree Master's Program in Science and Technology of Materials concludes with a commissioned master's examination amounting to 2 ECTS credits.
(2) The prerequisite for the commissioned master's examination is proof of the successful completion of all required exams and assessment of the master's thesis.
(3) The commissioned master's examination consists of the following components:
- Presentation of the completed master's thesis
- Defense of the master's thesis
- Oral examination on a compulsory module or a profiling/specialization module according to § 6 of the curriculum related to the master's thesis topic
- Oral examination on other interdisciplinary curriculum-relevant content.

The points (c) and (d) are conducted in relation to the master's thesis and establish curricular connections, resulting in the overall characteristic of a defense.

The examination committee consists of three members from both PLUS and TUM, with one being the supervisor of the master's thesis.

§ 14 Effective Date

This curriculum comes into effect on October 1, 2024.

§ 15 Transitional Provisions

(1) Students enrolled in the Joint Degree Master's Program in Science and Technology of

Materials at Paris Lodron University Salzburg (Version 2019, Official Bulletin – Special Edition 134, 56th Issue of April 24, 2019) at the time this curriculum comes into effect are entitled to complete their studies according to these study regulations until September 30, 2026, at the latest.

(2) Students have the right to voluntarily switch to this master's program within the admission periods at any time. A written, irrevocable declaration to this effect must be submitted to the admissions office.