



Deutscher Akademischer Austauschdienst  
German Academic Exchange Service



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# Master's degree



## Computational Materials Science (CMS)

TU Bergakademie Freiberg • Freiberg

### Overview

Degree	Master of Science (MSc)
Teaching language	<ul style="list-style-type: none"><li>English</li></ul>
Languages	The medium of instruction for all mandatory courses and seminars is English. You may choose to write your Master's thesis either in English or in German. The same applies to oral exams. Written exams are usually only in English.
Full-time / part-time	<ul style="list-style-type: none"><li>full-time</li></ul>
Programme duration	4 semesters
Beginning	Winter semester
Application deadline	15 April  Applicants from India can submit the APS (Academic Evaluation Centre) later and <b>do not have to submit it at the time of application</b> . The proof must be submitted with the enrolment at the latest.
Tuition fees per semester in EUR	None
Combined Master's degree / PhD programme	No
Joint degree / double degree programme	No

#### Description/content

The ever-accelerating **technological progress** of today's society requires engineers and scientists that are perfectly equipped with thorough knowledge of natural and materials sciences and who are highly skilled in programming and simulation techniques as well as in data handling and data analysis.

These "Computational Materials Scientists" will become **key players** in industrial R&D efforts; they will shape scientific and engineering research focusing on the design, processing and application of novel high-tech materials with superior mechanical, thermodynamic, and electronic properties.

At TU Bergakademie Freiberg, we bring together **renowned researchers and enthusiastic lecturers** from different scientific communities to offer our graduate students the education required for an outstanding career in computational materials science (CMS).

**Theoretical concepts** introduced during CMS lectures will be illustrated by **cutting-edge research**

**applications.** An intense introduction seminar will bring you up to speed with **scientific programming** and modern computing environments. During research seminars, you will have the possibility to **interact** with leading scientists and experienced engineers from industrial partners. During accompanying **hands-on tutorials**, the application of all relevant **state-of-the-art simulation methods** will be learned – which is only one of the truly outstanding aspects of this course. Elective classes will introduce you to specialised topics of computational engineering/mechanics – or even to advanced subjects of **data mining** and **machine learning** in data-driven materials science.

Among others, you will learn the theoretical background and hands-on application of the following numerical/simulation methods:

- linear/non-linear finite element methods (FEM)
- molecular statics and molecular dynamics (MS/MD)
- machine learning (ML), in particular deep learning (DL)
- Monte Carlo methods (MC)
- cellular automaton (CA)
- phase-field method (PFM)
- statistical analysis methods
- digital image analysis/correlation

CMS students are chosen among the top 3% of their undergraduate classes, ensuring an **intense study environment of excellence**. Small classes foster interaction and discussions, allowing you to develop your ideas. Furthermore, the study environment shines with an exceptional ratio of teaching staff to the total number of enrolled students.

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## Course Details

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### Course organisation

A minimum of four semesters (two years) is required to complete the programme. This MSc programme starts in the winter semester (an academic year has two semesters in Germany), and the language of instruction is English in all courses.

**The first semester** has the purpose of bringing all students to the same level of knowledge in materials science, continuum mechanics, and programming. This is the knowledge upon which the following semesters strongly build. Additionally, you will improve your German language skills, which will help you to explore the culture of Germany. Some of the most important courses during the first semester are:

- Fundamentals of Microstructures (FuMS)
- Mechanics of Materials (MoM)
- Properties of Materials (ProM)
- Metallic Materials (MeM), Semiconductors (Sem), Ceramic Materials (CeM)
- Introduction to Scientific Programming (ISP)
- Software tools for CMS (SoTo)

**The second semester** focuses on introducing important simulation methods, the accompanying theoretical and numerical concepts, and the advantages and pitfalls of all methods. Advanced aspects of materials science and engineering are introduced in hands-on approaches using dedicated simulation tools. Some of the most important courses are:

- Theory, Modelling, and Simulation of Microstructures (SiMS);
- Continuum Mechanics (Conti);
- Solid State Physics (SSP);
- Numerical Analysis (Num);
- Nonlinear Finite Element Methods (FEM);
- Software tools for CMS (SoTo), Part II;
- and an elective course in Machine Learning (ML).

**During the third semester**, you can additionally choose from elective courses, covering emerging topics such as data-driven materials science and big data methods or advanced topics of plasticity. Your programming skills will be further developed during the "**Personal Programming Project**", where you have to solve a problem of relevance for materials science, mechanics, or machine

learning by using the programming and simulation skills that you have acquired during the first two semesters. Further mandatory courses are:

- Theory, Modelling, and Simulation of Microstructures (SiMS), Part II;
- Experimental Methods of Materials Characterisation and Testing (Exp);
- Plasticity (Plasti);
- Introduction to High-Performance Computing and Optimisation (HPC);
- and a minimum of two to three elective courses such as Machine Learning.

The last semester is reserved for the Master's thesis.

For more details, see: <http://tu-freiberg.de/international-masters-program-in-computational-materials-science>

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<b>A Diploma supplement will be issued</b>	Yes
<b>International elements</b>	<ul style="list-style-type: none"> <li>• International guest lecturers</li> <li>• Study trips</li> <li>• Language training provided</li> <li>• Projects with partners in Germany and abroad</li> <li>• International comparisons and thematic reference to the international context</li> </ul>
<b>Integrated internships</b>	Internships at German companies are possible, but they are not mandatory.
<b>Course-specific, integrated German language courses</b>	Yes
<b>Course-specific, integrated English language courses</b>	No

## Costs / Funding

<b>Tuition fees per semester in EUR</b>	None
<b>Semester contribution</b>	94 EUR
<b>Costs of living</b>	760 EUR to 885 EUR per month, depending on individual lifestyle; rent and utilities: 200 EUR to 320 EUR
<b>Funding opportunities within the university</b>	Yes
<b>Description of the above-mentioned funding opportunities within the university</b>	<p>Deutschlandstipendium:</p> <ol style="list-style-type: none"> <li>1. The "Deutschlandstipendium" is a national scholarship programme that supports above-average students with excellent grades. Social commitment, a willingness to take responsibility and special social, family or personal circumstances will also be taken into account (six months, 300 EUR per month).</li> <li>2. Grants awarded to exceptionally committed students (three to four months, 300 EUR per month)</li> </ol>

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## Requirements / Registration

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### Academic admission requirements

#### Typical Candidates' Profiles

A typical CMS student is interested in materials, simulations and programming and is curious to know how things work. A distinctive feature of this student is that she/he would like to know how computer simulations and data analysis can be used to predict the behaviour of specimens, devices, or maybe even of yet non-existent "virtual materials" with superior properties.

Candidates who have a background in applied computer science, applied mathematics and similar subjects strive to achieve domain knowledge in linking software development and methods of deep learning with materials science in order to broaden their professional profiles.

#### Minimum Conditions for Admission to CMS

- **Bachelor's degree or an equivalent degree** in the field of Mechanical Engineering, Materials Science, Civil Engineering, Nanotechnology, Aerospace Engineering, (Solid State) Physics, Computational Engineering, Applied Maths, Applied Computer Science, or other comparable studies
- **Grade Point Average (GPA)** of at least 75% (this is equivalent to a German grade of 2.0, or 3.0 points of 4.0 maximum points in the United States grading system)
- **English certificate** (see below)
- Programming skills are an advantage.

### Language requirements

#### English:

- TOEFL with at least 90 points (Internet-based)
- IELTS score of at least 6.5

#### German:

- for the non-native speaker: no proof of German language skills is required (we recommend: Goethe Zertifikat A1: Start Deutsch 1 or telc Deutsch A1)
- no further requirements for native speakers

### Application deadline

15 April

Applicants from India can submit the APS (Academic Evaluation Centre) later and **do not have to submit it at the time of application**. The proof must be submitted with the enrolment at the latest.

### Submit application to

[Application portal of TU Bergakademie Freiberg](#)

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## Services

### Possibility of finding part-time employment

It is possible to find part-time employment on campus, e.g. as a student assistant or in the canteen.

### Accommodation

Different kinds of accommodations are available on campus and in the city of Freiberg, from single flats to shared flats. Prices vary from 200 EUR to 320 EUR, including utilities. In the dormitory, each student has her/his own room, but usually the bathroom and the kitchen have to be shared with

other flatmates. Living in a dormitory is usually the first choice for new international students. There is a good chance that you will get a place in a dormitory if you apply early. The International Office supports international students in finding accommodation.  
<https://blogs.hrz.tu-freiberg.de/iuz/accommodation/>

#### Support for international students and doctoral candidates

- Buddy programme
- Tutors
- Specialist counselling
- Cultural and linguistic preparation

#### Supervisor-student ratio

We limit our class sizes to 20–25 students. Each course unit consists of the lecturer (typically the professor) and one or two tutors, which results in a supervisor-to-student ratio of 1:7 for each class. This allows us, particularly during practice exercises, to adjust speed and style individually. It also guarantees optimal learning success.

## TU Bergakademie Freiberg

Technische Universität Bergakademie Freiberg (TU BAF) was founded in 1765. It is one of the world's oldest technical higher education institutions in the world, with an outstanding international reputation for its education and research based on the principle of constant innovation.

TU BAF is known for its famous alumni, such as the polymath Alexander von Humboldt, who studied in Freiberg, and for the discovery of two chemical elements: Germanium (C. Winkler, 1885) and Indium (F. Reich & Th. Richter, 1863).

TU BAF is the "University of Resources". With its four core themes – geosciences, materials, energy, and environment – TU BAF has a distinctive profile that addresses the specific issues of our modern industrial society. Teaching and research reflect a practical orientation in responding to the real needs of industry. Thanks to its financial backing, including funding from private sources, TU BAF is one of the top 10 best research-oriented universities in Germany. This guarantees a high level of education in the fields of natural sciences, engineering and economics.

Thanks to its excellent study conditions and intensive mentoring programmes, TU BAF achieves top positions in national rankings.

The university's underground teaching and research mine is open to visitors and serves as a natural laboratory. The mine allows for "hands-on" exploration of the subterranean world of Freiberg, with its extensive mining history dating back to the 14th century.

About 40% of the university's 4,000 students are international. As a small university, the campus offers numerous advantages. Short distances on campus and personal contact between students and professors are major benefits.

The university is divided into six faculties and has several research centres, such as the Interdisciplinary Environmental Research Centre (IÖZ), the Scientific Diving Centre (SDC), and the Mine Water Research Centre. The Helmholtz Institute Freiberg for Resource Technology, which was founded by TU BAF and the Helmholtz-Zentrum Dresden-Rossendorf (HZDR), researches new and innovative ways to explore high-tech metals such as gallium, indium, germanium, and rare earths.

The university and student initiatives offer a wide range of cultural events and leisure activities as well as more than 50 different types of sports activities at the university sports centre.



### University location

Freiberg is located in the centre of the state of Saxony in the picturesque Erzgebirge Mountains, 40 km south-west of Dresden and 240 km south of Berlin.

[Location on Openstreetmap.org](#)

Freiberg is more than 850 years old, and it was founded after the discovery of silver ore in 1168. Today, Freiberg has around 40,000 inhabitants. The medieval heart of the town, which is almost completely intact, is very attractive. It features the Upper Market Square with its late Gothic patrician houses and the Freiberg Cathedral at the Lower Market Square with its famous Silbermann organ and golden portal. Along with the world's oldest town theatre, a modern multiplex cinema, and nightclubs, more than a hundred restaurants, cafés, and pubs invite you to take a break and enjoy life.

There are sports facilities, a modern open-air and indoor swimming pool, and a park which surrounds the town centre like a green belt. Since 2008, the "Terra Mineralia" mineral collection has functioned as a centre of attraction for tourists, students, and inhabitants of Freiberg. The mineral collection, one of the largest collections in the world, is shown in the "Freudenstein", a refurbished castle in the town centre.

The nearby Saxon Switzerland National Park and the Erzgebirge Mountains are beautiful places for a wide variety of outdoor activities, including hiking and climbing in the summer and skiing in the winter. Dresden, Leipzig, and Berlin are easily accessible by train and offer plenty of social, cultural, and recreational alternatives.

## Contact

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🌐 Course website: <https://tu-freiberg.de/en/master-computational-materials-science>

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Last update 27.07.2024 14:31:54

# International Programmes in Germany - Database

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The publication is funded by the German Federal Ministry of Education and Research and by contributions of the participating German institutions of higher education.



Federal Ministry  
of Education  
and Research