

## Technical University of Darmstadt (TUD)

The Technische Universität Darmstadt (TUD) is one of the leading Technical Universities in Germany. The key competences are in the Engineering Faculties (Mechanical, Electrical and Civil Engineering), in Architecture and Informatics, Sciences (Physics, Chemistry, Biology) and Mathematics. In addition, the University has Faculties of Economics, and Humanities.

The combination of Engineering and Economics has a long and famous tradition at TUD. About 20.000 students are studying at present. According to the legislation in the state of Hesse, a Statute of Autonomy will be created for the University from 2005 on.

The Fachbereich Materialwissenschaft (now Institute for Materials Science) was founded in 1989. It has been conceived as a link between the engineers and the scientists. Its aims are the preparation of new materials, their characterization by physical techniques and their application for engineering purposes. Research is concentrated on the study of surfaces and interfaces, materials for energy transformation (solar and fuel cells) and nanomaterials.

The outstanding performance of the Institute has been acknowledged by the Deutsche Forschungsgemeinschaft (DFG) by the establishment of a Centre of Excellence (Sonderforschungsbereich) in 2004.

Research at the Institute is also supported by the Ministry of Research (BMBF), other DFG-programs and by the industry. About 60 PhD-students are currently involved in research programs.

Another key activity for the Institute is a program called Diplom-Ingenieur in Materialwissenschaft (Dipl.-Ing.). It is composed during the first two years of lecture courses, exercises and practical work in sciences and engineering for the first two years, after which teaching is concentrated on more specialized courses in Materials Science. Between 40 and 50 students are enrolled every year.

### Disciplines

- Methods of Materials Science
- Renewable Energy Systems
- Functional Layers
- Structural Materials
- Functional Materials
- Nano Materials
- Atomic Scale Modeling in Materials Science

### FAME Master format

Each year, 40 students will be recruited for Year 1 of the program and will start at INP Grenoble (France) or Augsburg (Germany). Half of the students will come from non-European countries and half from within Europe. Year 1 will provide a multidisciplinary teaching in the field of Functional Materials.

In Year 2 each student will specialize in scientific area offered by one of the 7 consortium universities. Students will have to study in at least two different universities and European countries.

### Curriculum offered in Darmstadt

The Institute for Materials Science at Darmstadt synthesizes and characterizes new materials for application in nanotechnology, thin-film-technique, sensors, solar-cells and catalysts with the aim of optimizing their technological properties.

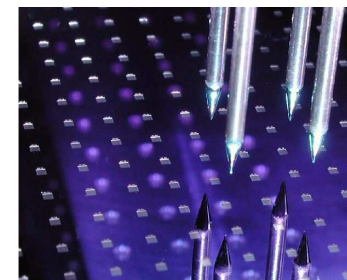
As member of the FAME Erasmus Mundus Consortium, the Technical University of Darmstadt will admit students for Year 2 of the FAME Master.

These students will have chosen the **Functional Ceramics specialization (Processing, Characterization and Properties)** for the final part of their Master's program and will graduate with a **double-diploma**.

Students who do not apply for the official Erasmus Mundus Master of Science curriculum and wish to attend Year 1 must have earned a Bachelor's degree in Science (Physics, Chemistry, Metallurgy, Materials Science, Electrochemistry).

Those who wish to attend Year 2 (Semester 3) must have passed Year 1 of a Master degree in the Materials Science area of a high-standing university.

At the end of their studies, such students will only be awarded a national diploma and not the official Erasmus Mundus FAME Master of Science label.



## Course description (Semester 3) 30 ECTS\*

\*ECTS: European Credit Transfer System

### Practical Courses 6 ECTS

Sol-gel synthesis methods  
Powder X-Ray Diffraction (XRD)  
Transmission Electron Microscopy (TEM)  
Reciprocal space mapping and X-Ray Reflectivity (XRR)  
Infra Red Spectroscopy (IR)  
X-ray Fluorescence Spectrometry (XRS)  
Inductively Coupled Plasma Spectrometry (ICP)  
Atomic Absorption Spectroscopy (AAS)  
Electron Probe Micro Analysis (EPMA)  
Secondary Ion Mass Spectrometry (SIMS)  
Characterization of a lambda probe  
Lithium Batteries  
Fuel Cells

### Lectures 16 ECTS

Atomic Scale Modeling in Materials Science (2 lecture + 1 tutorial) 4 ECTS  
Methods (2 lectures + 1 tutorial + 1 seminar, 6 ECTS  
Synthesis and processing of Ceramics (2 lectures) 3 ECTS  
Properties of ferroelectrics (2 lectures) 3 ECTS

### Courses 8 ECTS

Processing of conventional and polymer derived Silicon Ceramics 2 ECTS  
XRD Course 3 ECTS  
TEM Course 3 ECTS

### Staff involved in the FAME Master

- Prof. Hartmut Fuess
- Prof. Jaegermann (Dean of the Faculty)
- Prof. Riedel
- Prof. Rödel
- Prof. Von Seggern
- Prof. Roth

The research groups **Structure Research, Chemical Analysis, Surface Science, Electronic Material Properties, Thin Films, Ceramics Group and Materials for Renewable Energies** investigate on various fields including Solar Cells, OLED, Fuel Cells, Catalysts, Batteries, processing of ceramics, electric fatigue of ceramics, nano wires, and simulation.

### Research partners



- FAME European partners (Germany, UK, Belgium, Spain, Portugal)
- University of Ankara, Turkey
- Technical University Bratislava, Slovakia
- Tsinghua University of Beijing, China
- University of Sfax, Tunisia
- Ivan-Franko-University Lviv, Ukraina
- Anadol Universityt, Turkey
- UNSW, Sydney, Australia
- Purdue University, USA
- Imperial College, London, UK
- KAIST, Korea
- University, Milan, Italy
- University Vilnius, Lithuania

### Selected industry partners

- AIXTRON
- HERAEUS HOLDING GmbH
- MATERIALS VALLEY e.V.
- MOTOROLA GmbH
- NEUE MATERIALIEN WÜRZBURG GmbH
- UMICORE
- HENKEL KGaA
- SUSTECH GmbH&Co. KG Darmstadt
- GENERAL MOTORS POWERTRAIN (Germany)
- MERCK KGaA
- DAIMLERCHRYSLER AG
- ANTEC Solar Energy AG

### Facilities used for research

The Institute for Materials Science at Darmstadt University of Technology houses the following instrumentation:

- Transmissions-Electron-Microscopes (TEM, HRTEM, EELS, EFTEM, EDX)
- X-Ray Diffractometers (XRD, XRR, GIXD)
- Beam-lines at the Synchrotron DESY in Hamburg (XRD, XANES, EXAFS) and BESSY II (PES, XAS)
- Beam-line at the Neutron Diffractometer FRM II in Munich (INS, NRSE, NTD)
- Secondary Ion Mass Spectrometer (SIMS)
- Electron Probe Micro-Analyser (EPMA),
- Scanning Electron Microscopy (SEM) and many other methods like STM, AFM, XPS, UPS, ICP, DSC, DTA



### Typical Master Thesis projects/subjects

- First-principles study of ferroelectric nano-structures and of multiferroic compounds
- Effective Hamiltonian study of the finite temperature properties of ferroelectric oxides
- Electronic dynamics in a linear chain of metallic quantum dots and implementation of ternary logic gates
- Mössbauer spectroscopy and magnetometric analysis of alluaudites and nanoparticles.
- Vanadium oxide thin films produced by sol-gel chemistry and DC Plasma sputtering for thermochromic applications
- New intercalation compounds for reversible Li-insertion to be used in Li-ion batteries as cathodes
- TiO<sub>2</sub> photocatalytic materials produced by a co-gelation process

### Other equipment used at TUD

- Atomic Absorption Spectroscopy
- Atomic Force Microscopy
- Differential Thermal Analysis - Differential Scanning Calorimetry
- Electron Energy Loss Spectrometry
- Electron Probe Microanalysis
- Environmental Scanning Electron Microscopy
- Fluorescence Spectroscopy
- Fourier Transform Infrared Spectroscopy
- Grazing Incidence X-Ray Diffractometry
- Inductively Coupled Plasma Analysis
- Photo Emission Electron Microscopy
- Scanning Electron Microscopy
- Secondary Ion (Surface) Mass Spectrometry
- Sol-Gel Film Processing
- Transmission Electron Microscopy
- Thermo Mechanical Analysis
- Ultraviolet Photoemission Spectroscopy
- X-Ray Photoemission Spectroscopy