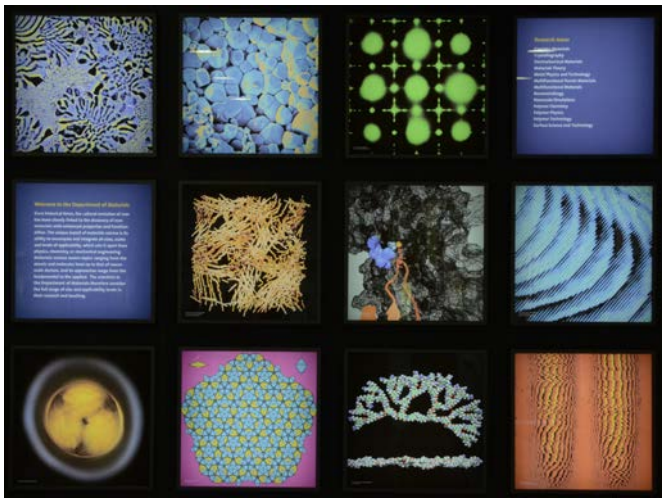
ETH zürich

DMATL
Department of Materials

Master Programme in Materials Science at ETH Zurich



ETH Zurich is one of the leading international universities for technology and the natural sciences.

It is well-known for its excellent education, ground-breaking fundamental research and for putting its new findings directly into practice. It offers researchers an inspiring working environment and its students a comprehensive education.

ETH Zurich regularly appears at the top of international rankings as one of the best universities in the world. 21 Nobel Laureates have studied, taught or conducted research at ETH Zurich, underlining the excellent reputation of the institute.

The objectives of the **Department of Materials at ETH Zurich** are to conduct world-class materials research and to produce materials scientists and engineers who are educated at the highest level. In both research and education, the department is committed to the idea of materials science spanning many orders of magnitude in size scale, from atoms to products, and also stretching from highly fundamental studies to those with direct technological implications.

The Materials Department counts 350 members, in which more than 80 nationalities are represented. All members are divided into 16 research groups listed on page 7. Representatives of many different cultures work next to each other on a day to day basis, enhancing not only the quality of the scientific work but also enrichening all individuals. English is the main spoken language. Research groups feature a group head and can additionally consist of a secretary, assistant professors, senior scientists, postdoctoral students, doctoral students, master thesis students, master project as well as bachelor thesis students. Naturally, the number of group members largely depends on the group's age and the amount of available projects. Typically, newly founded groups grow very quickly.

The Materials Department offers one Bachelor degree course as well as one Master degree course. Currently, there are about 200 students enrolled in the bachelor and circa 100 students enrolled in the master degree course. Master students not only attend courses but are also integrated into research groups by working on two eight-week master projects as well as a 6-month master thesis. This grants insight into various different research groups and therefore topics and also trains them in various scientific fields. According to project availability Master students can choose a research group of their wish to complete the projects in. A welcome side effect of laboratory work is the social interaction crossing the boundary of the master degree classes.

In order to complete the Materials Science Master degree course 120 credit points (CP) need to be achieved. Those 120 CP are obtained in the core, elective and GESS course category as well as by doing two master projects and a master thesis. The master program structure is laid out in more detail on the next.

Material's Master degree course structure

The Master degree course in Materials at ETH Zurich is designed to be a two year, full time study program during which 120 Credit Points (CP) are earned in 4 different categories listed below. Master degree holders are awarded the title Master of Science ETH in Materials. The maximum study duration for the Master degree course is 8 semesters.

1. Core courses (30 CP)

At least 30 CP need to be earned in the core course category. The entirety of all offered classes amounts to 44 CP at the maximum. Core Courses are courses dedicated to overarching themes in the field of materials science. They form the basis of the master program since they provide students with core knowledge in problem-oriented perspectives.

All core courses are organized by the materials department but guest lectures e.g. from industry may be an integral part of the classes. Core courses are divided into two parts: part I and part II. Part one of every core course is held in the fall semester, part II in the subsequent spring semester. It is recommended to attend part one of a core course before enrolling in part II, but there is no obligation to do so. All core courses are held in English, take place on the Hönggerberg campus and are completed with a written examination at the end of the semester. If failed, core course examinations can be repeated once. A short description with the day and time of the lecture and the corresponding credit points is given on page 3 along with the day and time the classes are held.

2. Elective courses (30 CP)

Additional 30 or more CP are earned in the elective course category. All elective classes can be chosen individually by each student. These courses should deepen the student specific knowledge in scientific and technical regard as well as broaden the student's subject related background. All master level courses at ETH allowed as elective classes. A list of recommended elective classes is given on page 5. Note that the recommended courses are not mandatory in any respect. Students are encouraged to individually create a curriculum tailored to their needs and interests.

It is highly recommended that students take enough time to choose and organize their elective courses. This is due to the fact the variety in possible courses is enormous and because the core course underlie a fixed schedule.

3. D-GESS courses (6 CP)

On Master-level too, students are encouraged to benefit from the general educational course offering, represented by the GESS-Department. The students are thereby enabled to gain profound basic knowledge in various different domains other than their specialist discipline. The range of classes is extraordinarily large, from political science to philosophy through to business administration. (*www.gess.ethz.ch)*

4. Master Projects and Master Thesis

This last category serves to put the gained knowledge directly into context by performing experiments of one's own.

Master Project 1 and 2 (12 CP each): A Master project is an 8-week project to practice individual scientific activity. The students support the research work of a research group at ETH Zurich, thereby enhancing their laboratory knowledge and skills. Not only do they obtain insight into the state of research in a specific field, they also contribute to its development. If fewer time than 5 days per week is dedicated to the master projects (e.g. due to lectures) the duration of the master projects is extended in a way, that the total working time amounts to eight weeks.

Master Thesis (30 CP): The Master's thesis concludes the Master's programme. It constitutes a six-month, full-time project aimed at advancing the skills and capabilities of students to work independently and creatively toward the solution of an independent research problem. The topic has been agreed upon in advance. The master thesis generally takes place during the entire 4th semester of the master's program and is conducted in a D-MATL research group. In the past, the academic quality of those projects has shown to be outstanding. During those six months the students are supported by PhD students, post-docs and professors.

Core Courses

At least 30 CP out of the following courses:

Autumn Semester

327-0505-00L - **Surfaces, Interfaces & their Applications I** (3CP)

N. Spencer, M. P. Heuberger
Mon 09-12

After being introduced to the physical/chemical principles and importance of surfaces and interfaces, the student is introduced to the most important techniques that can be used to characterize surfaces. Later, functionalization of surfaces is treated, followed by an introduction to the fields of tribology (friction, lubrication, and wear) and corrosion.

327-1201-00L - **Transport Phenomena I** (4CP)

H.C. Öttinger
Mon 13-17

In this course we study Phenomenological approach to "Transport Phenomena" based on balance equations supplemented by thermodynamic considerations to formulate the undetermined fluxes in the local species mass, momentum, and energy balance equations; fundamentals, applications, and simulations.

327-1203-00L - **Complex Materials I: Synthesis & Assembly** (4CP)

M. Niederberger, A. H. Kahn
Tue+Thu 15-17/09-11

This course is an introduction to materials synthesis concepts based on the assembly of differently shaped objects of varying chemical nature and length scales.

327-1202-00L - **Quantum Enabled Materials I** (4CP)

N. Spaldin
Wed 09-13

In this course we study how the properties of solids are determined from the chemistry and arrangement of the constituent atoms, with a focus on materials that are not well described by conventional band theories because their behavior is governed by strong quantum-mechanical interactions.

327-1004-00L - **Materials at Work I** (4CP)

R. Spolenak, R. Koopmans
Thu 11-15

The course "Materials at Work" focuses on the challenges of a materials engineer in the industrial environment. This ranges from materials selection over the environmental and political impact of materials to the specifics of the main materials classes: polymers, metals and ceramics in processing and application.

376-1714-00L - **Biocompatible Materials I** (4CP)

K. Maniura, P. M. Kollmannsberger
Fri 09-12

This course in an introduction to compounds used to fabricate biomaterials, molecular interactions between different materials and biological systems (molecules, cells, tissues). The concept of biocompatibility is discussed and important techniques from biomaterials research and development are introduced.

Spring Semester

327-2203-00L - **Complex Materials II: Structure & Properties** (4CP)

J.F. Löffler et al.
Mon 09-13

The course presents structure-property relationships in complex materials, such as photonic, phononic or ferroic crystals, heterostructures, and disordered materials.

327-2201-00L - **Transport Phenomena II** (4CP)

H.C. Öttinger
Mo 13-17

In this course we study the numerical methods for real-world "Transport Phenomena"; atomistic understanding of transport properties based on kinetic theory and mesoscopic models; fundamentals, applications, and simulation.

327-2202-00L - **Quantum Enabled Materials II** (4CP)

R. Spolenak
Tue 09-13

The core of this course explains how the behavior of materials changes, when their external dimensions become small (usually on the micro- to nanometer length scale). This is illustrated by examples from all materials classes and further substantiated by case studies of applications ranging from micro- and nanoelectronics to optoelectronics.

327-2205-00L - **Surfaces, Interfaces & their Applications II** (3CP)

N. Spencer, P. Schmutz
Wed 09-12

This part of the course will be an introduction in the fundamental aspects of surface degradation mechanisms induced by (electro)chemical and mechanical interactions. Surface physico-chemical processes on metals/alloys exposed to liquids will be introduced and the different electrochemical methods necessary for the characterization of the solid-liquid interface will be presented.

327-2204-00L - **Materials at Work II** (4CP)

R. Spolenak, D. Hegemann
Thu 13-17

The course "Materials at Work" focuses on the challenges of a materials engineer in the industrial environment. This ranges from materials selection over the environmental and political impact of materials to the specifics of the main materials classes: polymers, metals and ceramics in processing and application.

376-1614-00L - **Biocompatible Materials II: Principles in Tissue Engineering** (2CP)

K. Maniura et al.
Fri 09-11

Fundamentals in blood coagulation; thrombosis, blood rheology, immune system, inflammation, foreign body reaction on the molecular level and the entire body are discussed. Applications of biomaterials for tissue engineering in different tissues are introduced. Fundamentals in medical implantology, in situ drug release, cell transplantation and stem cell biology are discussed.

Elective Courses

Circa 30CP out of all courses on master level offered in one of the master programs of ETH Zürich, e.g.:

Autumn Semester

327-4101-00L - Durability of Engineering Materials (2CP)
M. Diener; Mon 11-13

327-2103-00L - Advanced Composite and Adaptive Material Systems (4CP)
G. P. Terrasi, F. J. Clemens; Mon/Tue 09-11/16-18

402-0809-00L - Introduction to Computational Physics (8CP)
H. J. Herrmann; Tue 09-13

752-2314-00L - Physics of Food Colloids (3CP)
P. A. Fischer, R. Mezzenga; Tue 13-15

327-2105-00L - Supramolecular Aspects of Polymers (2CP)
P. J. Walde; Tue 14-15

327-1220-00L - Crystal Optics with Intense Light Sources (4 CP)
M. Fiebig; Wed 13-16

529-0947-00L - Basic Polymer Synthesis (6CP)
A. D. Schlüter; Wed 13-16

327-0703-00L - Electron Microscopy in Material Science (4CP)
H. Gross et al.; Wed/Fri 11-13/12-14

402-0313-00L - Materials Research Using Synchrotron Radiation (6CP)
J. F. van der Veen, B. Schönfeld; Thu 09-11

151-0605-00L – Nanosystems (5CP)
A. Stemmer, A. Rey; Thu 10-12

327-0702-00L - EM-Practical Course in Materials Science (4CP)
K. Kunze et al.

Spring Semester

327-2221-00L - Advanced Surface Characterisation Techniques (4CP)
A. Rossi Elsener-Rossi; Tue 14-18

327-4105-00L - Integrity of Materials and Structures (4CP)
M. Roth et al.; Wed 08-12

327-2104-00L - Inorganic Thin Films: Processing, Properties and Applications (2CP)
T. Lippert, C. Schneider; Wed 13-17

151-0060-00L - Thermodynamics and Energy Conversion in Micro- and Nanoscale Technologies (4CP)
D. Poulikakos et al.; Wed 13-17

327-3105-00L - Business and Process Management (BAPM) (4CP)
W. Lüthy; Thu 15-18

327-2220-00L - Materials for Energy and Environmental Sustainability (2CP)
J. VandeVondele et al.; Thu 09-11

151-0622-00L - Measuring on the Nanometer Scale (2CP)
A. Stemmer; Thu 10-12

529-0942-00L - Advanced Polymer Synthesis (6CP)
A. D. Schlüter et al.; Thu 14-17

327-5102-00L - Computational Polymer Physics (4CP)
E. Del Gado, J. Colombo; Fri 14-18

Student exchange (Mobility)

In the Material's Master program 40 CP can be earned at a university other than ETH Zurich at the maximum. The credit points earned can originate from the elective and/or GESS course categories or be obtained by master project(s) or thesis. Core courses must be completed at ETH Zurich, D-MATL, and can not be replaced by any similar class at a different university. Information about terms and regulations is offered below.

Elective courses (min. 30 CP) and/ or D-GESS courses (min. 6 CP)

Students wishing to spend some time abroad can acquire the full 30 CP from the elective course category at a different university of their choice. All D-GESS course requirements can be fulfilled abroad too, as long as the chosen classes are comparable to the D-GESS course catalogue at ETH Zurich.

The curriculum wished to be fulfilled abroad must be discussed with the head of studies at the Materials Department, Prof. Dr. Öttinger.

Master projects 1 & 2 (12 CP each)

Master projects can be completed in any research group at ETH Zurich or abroad. All CP earned by projects carried out at ETH Zurich in a department other than D-MATL are not counted towards the 40 CP obtainable by abroad classes/ projects.

Master thesis (30 CP)

Master theses may be conducted abroad. Doing so will only be permitted after a qualified D-MATL professor agrees to take on the thesis' technical responsibility. This means that a D-MATL professor must assess the thesis' quality and confirm that it meets ETH Zurich standards. He also has to agree upon the thesis' recommended grade, given by the supervisor abroad.

More information

For all detailed requests please contact the head of the mobility program at D-MATL the Materials department, Prof. Dr. Peter Walde (peter.walde@mat.ethz.ch).

Application to the Master degree course in Materials

General Information

There are two application periods:

1) November 1st – December 15th
2) March 1st – April 15th

Students applying for the Materials Science Master program may be asked to fulfill additional requirements to be admitted to the master program, depending on the scope of already attended courses. Those additional requirements usually are Materials Science Bachelor classes. In some cases the additionally required classes are held in German only. In those cases the students must prepare for the exams in self-study. The time span to fulfill imposed conditions is 18 months at the very maximum, possible exam repetitions included. If, after 18 months the conditions have not been met, the student will be exmatriculated automatically and inevitably.

The Rectorate receives all applications. The application form and detailed information about the application can be found on the web:
Information/guidance: www.admission.ethz.ch/master

A non-refundable handling fee is payable with the application. There is no fee for candidates from ETH Zurich, EPF Lausanne and holders of an IDEA League Scholarship.

D-MATL Research Groups 2013

COMPLEX MATERIALS
Prof. André Studart

CRYSTALLOGRAPHY
Prof. Walter Steurer

ELECTROCHEMICAL MATERIALS
Prof. Jennifer Rupp

INTERFACES, SOFT MATTER AND ASSEMBLY
Prof. Lucio Isa

MAGNETISM AND INTERFACE PHYSICS
Prof. Pietro Gambardella

MATERIALS THEORY
Prof. Nicola Spaldin

MESOSCOPIC SYSTEMS
Prof. Laura Heyderman

METAL PHYSICS AND TECHNOLOGY
Prof. Jörg F. Löffler

MULTIFUNCTIONAL FERROIC MATERIALS
Prof. Manfred Fiebig

MULTIFUNCTIONAL MATERIALS
Prof. Markus Niederberger

NANOMETALLURGY
Prof. Ralph Spolenak

NANOSCALE SIMULATIONS
Prof. Joost VandeVondele

POLYMER PHYSICS
Prof. Hans Christian Öttinger

POLYMER CHEMISTRY
Prof. A. Dieter Schlüter

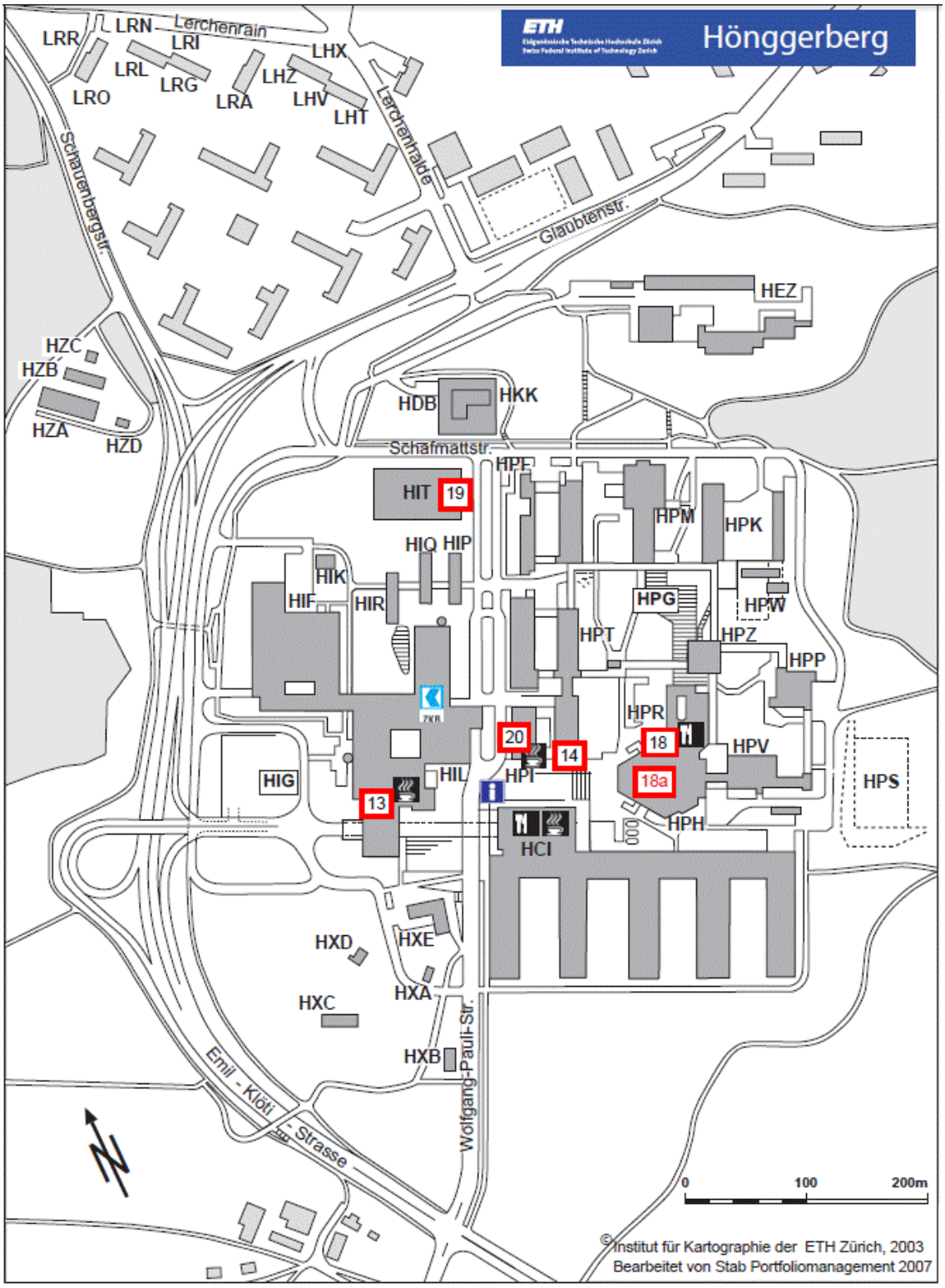
POLYMER TECHNOLOGY
Prof. Paul Smith

SURFACE SCIENCE AND TECHNOLOGY
Prof. Nicholas D. Spencer

Possible research topics: Many of the possible research topics are listed below. Please note that the topics are subject to change at any time and serve only to give an impression.

new fabrication routes for artificial complex materials, development of novel crystallographic techniques and methodologies, and the application of these methods to materials of non-biological origin, mass and charge transport for information storage and energy devices, magnetic phenomena in interface systems spanning the range from single atoms to multilayer films, fundamental physics of novel materials with potential technological importance, magnetic and multiferroic thin films and nanostructures, bulk metallic glasses, magnetism on mesoscopic scales, nano-optics, metals for medical applications, microstructure analysis and modeling, light metals, materials where strong coupling between electrons leads to novel types of ordering processes of its spins and charges, metal oxide nanoparticles, metallurgy, ab initio molecular dynamics simulations of complex systems, model complex fluid behavior on different autonomous levels of description, dendronized polymers, suzuki polycondensation, two dimensional polymers, responsive polymers, Belt-shaped macrocycles and their polymerization into two-dimensional networks, processing of intractable polymers, polymer nucleation, polymer metals, semi- conductiong polymers, surface functionalization, tribology, biomedical interfaces, surface forces, advanced surface analytical techniques, etc.

Location of D-MATL



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