Empa. Materials Science and Technology.

EMPA
Materials Science & Technology

Empa in Brief

Our Vision. Materials and Technologies for a Sustainable Future.

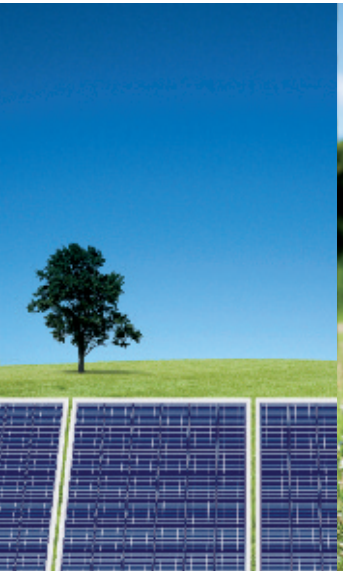
Mission Statement

Empa conducts cutting-edge materials and technology research, generating interdisciplinary solutions to help overcome major challenges faced by industry, and creates the necessary scientific basis to ensure that our society develops in a sustainable manner.

In colaboration with partners from industry, Empa turns research results into marketable innovations. In doing so the institution makes a significant contribution to enhancing the international competitiveness of the Swiss economy.

As an institution of the ETH Domain, Empa is committed to excellence in all its activities.

Meeting today's challenges requires innovative materials and sustainable technologies.



Research Focus Areas

Where are today's big challenges? There is certainly personal health and well-being, climate and the environment, our dwindling natural resources, a safe and sustainable energy supply and the renewal of our infrastructure, to name but the most urgent ones. Empa is trying to provide answers by concentrating its R&D activities within five Research Focus Areas, thus making the most efficient use of the interdisciplinary know-how in its 29 research laboratories.

- **Nanostructured Materials**
- **Sustainable Built Environment**
- **Natural Resources and Pollutants**
- **Materials for Health and Performance**
- **Materials for Energy Technologies**

What are the questions we deal with in the Focus Area Nanostructured Materials?

What novel functionalities can be achieved using tailor-made nanostructured materials, coatings and surfaces?

Where are the ultimate limits to the miniaturization of modern microelectronics using semiconductor manufacturing techniques?

Do supramolecular structures formed by self-assembly provide new solutions to the engineering challenges of the 21st century?

What risks do nanomaterials represent for mankind and our environment?

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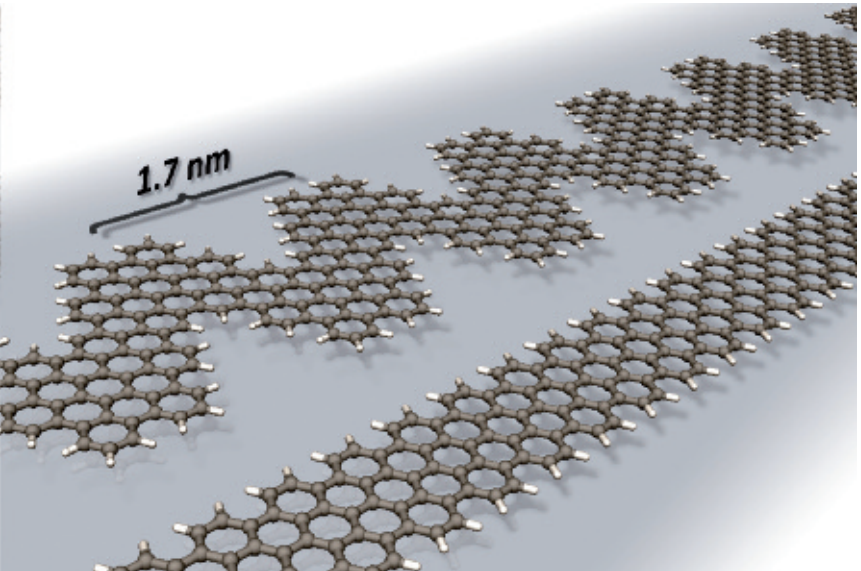
Nanostructured Materials



Entry into the nano-world gives access to the basic elements of our materials. This allows us to develop new materials and coatings with tailor-made functional properties to solve technological problems. Empa has established itself as a leading Swiss R&D institution in the field of nanotechnologies, the applications-oriented exploitation of nanoscale effects. We can call upon our broad spectrum of interdisciplinary know-how in this scientific field at the interface of physics, chemistry and biology. In collaborative projects we use our competences and experience to develop promising new applications. For example we help uncover innovative solutions for sustainable energy technologies and are working together with the IT industry on novel materials and concepts for micro- and nanoelectronics. Other future-oriented projects are exploring the use of evolutionary construction principles found in nature. The risks for mankind and the environment involving this key technology are also being studied at Empa.

What are the questions we deal with in the Focus Area

Sustainable Built Environment?

How can we minimize the environmental footprint of construction materials and technologies?

Which materials and systems are most suitable for the renewal of existing buildings and infrastructures?

What is the impact of smart materials and systems in civil engineering?

How can we boost innovation and technology transfer in a highly fragmented industry sector?

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Sustainable Built Environment

The quality of the built environment is a key factor for a truly sustainable society. This includes high-quality and affordable living and working space, networks for transportation of people and goods and a reliable distribution of energy, water and information. Research is carried out at different levels starting from the development of new materials to the design of advanced systems and their integration into buildings and structures. Finally, we also look at entire cities and their interaction with the environment. Key issues at all levels are the minimization of the environmental footprint and the enhancement of comfort and safety offered by the built environment to its users. Technology transfer to industry is fostered by large-scale demonstration projects.

What are the questions we deal with in the Focus Area

Natural Resources and Pollutants?

Where do atmospheric pollutants come from, what happens to them after release?

How do pollutants interact with materials and technical systems?

How can we promote the introduction of Cleantech applications?

Will the scarcity of rare elements be a problem for future high-tech applications, e.g. noble metals for exhaust gas cleaning or rare earths for ICT hardware?

How can we shape an individual mobility for tomorrow, based on sustainability?

How can we purify exhausted gases in an energy- and material- efficient way?

Dr. Peter Hofer
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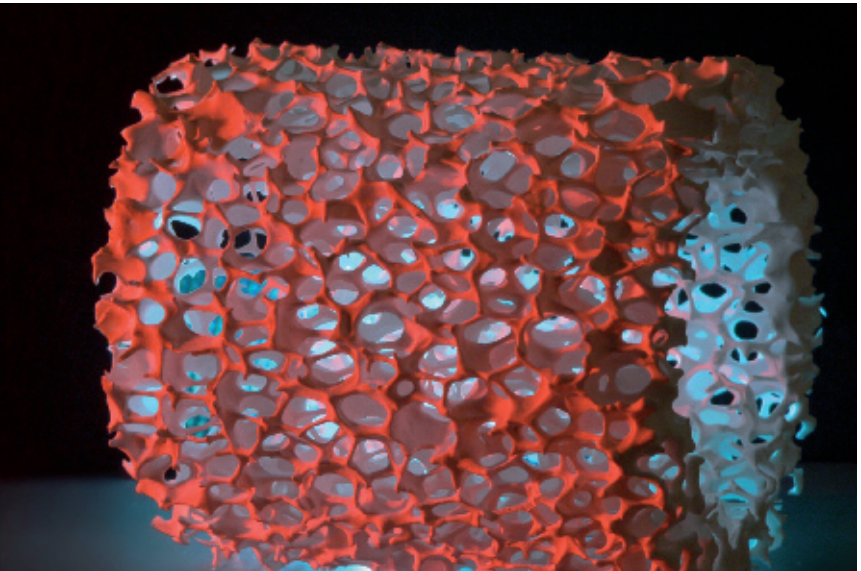
Natural Resources and Pollutants



Every society requires materials and energy to fulfil its needs and pursue its dreams, such as heated or cooled buildings, individual mobility, food and goods for everyday life. We promote a society that uses fewer natural resources and produces fewer pollutants by understanding the underlying physical and chemical processes and developing innovative technical solutions. We therefore study key processes like individual mobility and industrial production, which are accompanied by the release of numerous pollutants: greenhouse gases, volatile organic chemicals, particles and others. We investigate the atmospheric distribution of these pollutants on different scales, from the flow around buildings to the transport over continents. And we explore new ways and means of cleaning exhaust gases to lower the pollution of our environment.

What are the questions we deal with in the Focus Area

Materials for Health and Performance?

Which materials can contribute to maintaining human health – or even restore it?

Which future products can improve the quality of life and safety of the elderly?

How can we improve performance during sports activities or under extreme environmental conditions?

How can we develop and functionalize fibers and textiles to endow them with specific properties?

Can we guarantee the safety of new materials? And how do we even test for it?

Prof. Dr. Harald Krug
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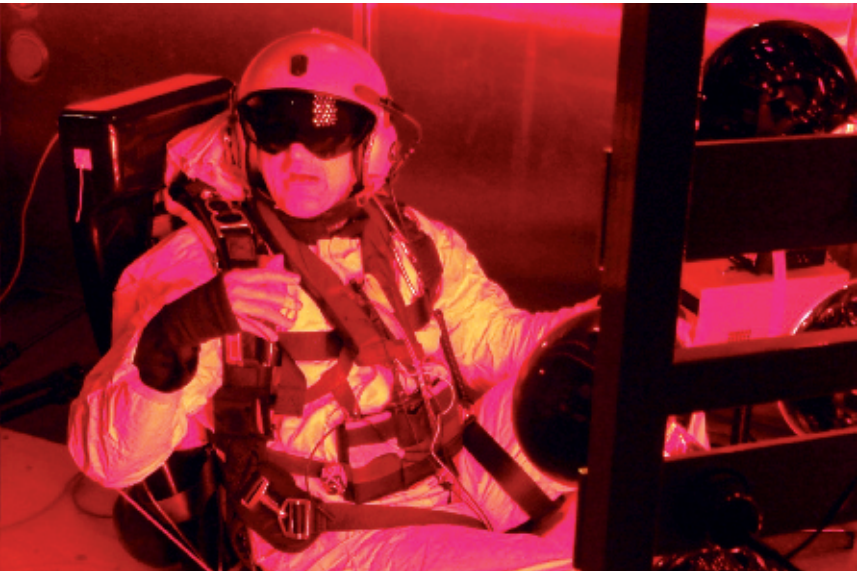
Materials for Health and Performance



Protect people, promote good health in a sustainable manner, maintain and improve our quality of life and our physical capacity – these are ever more significant topics, especially in the light of trends that predict a continuously increasing life expectancy. We take on this challenge, using an interdisciplinary approach combining know-how and experience from textile and materials sciences, from biology and nanotechnology. We break new ground in the synthesis of biopolymers or important precursor molecules for chemical synthesis via biocatalysis, and we focus on materials for medical applications within the human body and on materials and systems that protect and assist us in our daily lives. Moreover, we investigate the safety of new materials by developing innovative testing methods.

What are the questions we deal with in the Focus Area

Materials for Energy Technologies?

How can the energy efficiency for buildings and for mobility be improved?

What kind of advanced materials can contribute to the development of new energy conversion technologies?

What is the best way of creating efficient and reliable energy systems?

What effects do new energy technologies have on the environment, society and the economy?

What are the best future energy storage options?

What is the contribution of renewable energy souces to a sustainable future?

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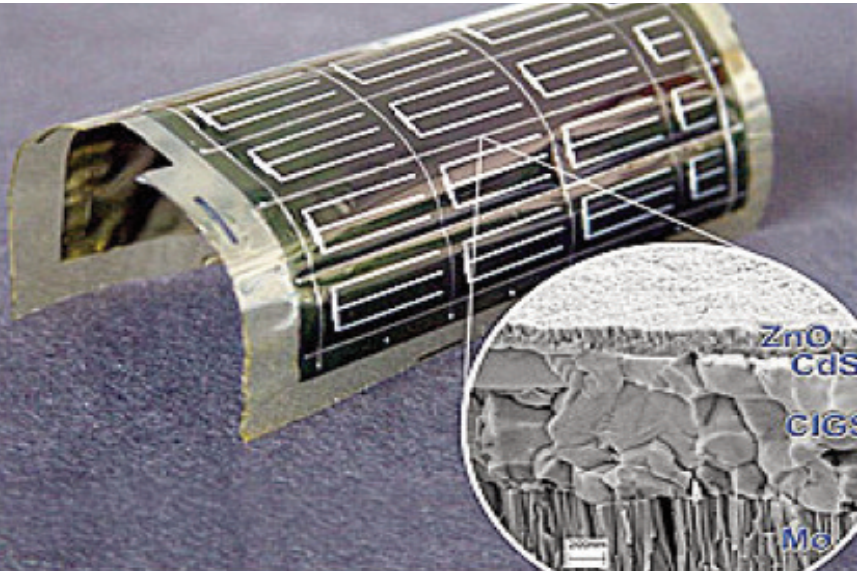
Materials for Energy Technologies



On global average, each individual «consumes» about 17'500 kWh of energy annually for producing food and goods, for heating, cooling and for mobility. In Switzerland, however, the figure is three times higher, i.e. well above the limit set as goal for the 2000 Watt Society (which would correspond to a CO_2 emission from fossil fuels of about 1t per person). Bringing down this figure requires new energy concepts and technologies. With a vision of reducing power consumption by two thirds, we are conducting research into advanced materials, processes and systems for the conversion and storage of energy. We are investigating ways to design more efficient energy systems, to reduce conversion losses and to increase exploitation of renewable energies while minimizing the risks posed by these new technologies through sustainability assessments.

The Academy

Keeping abreast of the rapid pace of technological progress in industry, the economy and society demands a broad overview of a wide range of research and development fields. The Academy is Empa's platform for knowledge transfer, used by experts from industry and academia as a vehicle for the dialog with each other, but also with a wider, non-specialist audience.

The Academy has taken on the task of disseminating to a wider public the know-how gained in the course of our numerous research projects and investigations. It offers our clients an open access to Empa's greatest strengths – the width of our interdisciplinary experience, the depth of our scientific expertise, our continuity and our widespread network of national and international partners.

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EMPA AKADEMIE
Zentrum für Wissenstransfer

www.empa-akademie.ch

The Academy organizes seminars, conferences and lecture courses for scientists and experts from industry, regulatory authorities and technical associations. In addition to the specialist technical and scientific activities, we also arrange events specifically for the wider, non-specialist public.

In particular, knowledge transfer from research to industry is dear to our heart. For this purpose we have developed the “Technology Briefing” series. Through short presentations with accompanying exhibitions we present opportunities for the practical implementation of new developments derived from our research.

Knowledge and Technology Transfer

Supporting the Value Chain from Invention to Innovation

With an efficient knowledge and technology transfer Empa assures that new technologies, materials and methods are available for interested partners to be developed further into innovative products and applications.

A key to this mission is to seek ways to connect Empa's researchers and labs with potential partners from industry through the Empa Portal. The Portal offers a single point of contact for those looking for cooperation with Empa and its broad offering in use-inspired research and sophisticated services.

Empa embraces and supports the cooperation between its researchers and industrial partners in Switzerland and abroad. Collaborations can have various forms e.g. contract research, joint research, publicly funded research or consulting, and can be aligned with the requirements of SMEs and start-ups as well as large enterprises.

To create the best possible conditions for future development and marketing, Empa aims to file property rights early on and to offer them to its partners for commercial use.

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Portal

3 Sites

1 Dübendorf

2 St. Gall

3 Thun

Facts & Figures 2011

~ 1000 scientific, technical and administrative staff
> 500 peer-reviewed (SCI/E) publications
200 undergraduates (Master/Bachelor) and interns
140 PhD students
97 million CHF in federal funding
> 90 running SNSF projects
85 seminars, lectures and conferences held at the Empa Academy
80 running CTI projects
50 million CHF in third-party funding
> 50 running EU Framework Program projects
36 apprentices
24 professors
6 departments with 37 laboratories and sections
5 interdisciplinary Research Focus Areas
3 sites
1 Empa

Chronology

In **1880** the "Institution for the Testing of Building Materials", the forerunner to Empa, begins its work. Its first Director is Dr Ludwig von Tetmajer, Professor of Building Materials. The Institution is located at the Polytechnic in Zurich.

In **1891**, Tetmajer is given the task of investigating the collapse of a railway bridge near Muenchenstein, built by the famous engineer Gustav Eiffel. Tetmajer is quickly able to demonstrate that the use of Euler's hyperbola, which up to that time had been the standard technique, is only applicable in the elastic region of the steel used for the bridge.

In **1895** the designation "Federal Materials Testing Institute" is first used, the German acronym for which is "Empa".

In **1937** the Swiss Testing Institution, St.Gallen, having been expanded in 1911 to a textile testing authority, merges with Empa. The expanded organization is renamed the "Federal Material Testing and Experimental Institute for Industry, Civil Engineering and Trade".

In **1962** Empa moves from Zurich to Dubendorf. The key areas at this site are civil engineering, safety technology, surface technology, metallic materials, composites, non-destructive testing, chemical analysis, exhaust gas and atmospheric measurements, building technologies, building physics, acoustics and noise abatement.

In **1988** a significant change of course occurs, with increased emphasis placed on research. Empa is renamed "Federal Material Testing and Research Institute". The research strategy is guided by a newly established Research Commission.

In **1994** the staff of the Armaments Services Group in Thun joins Empa and establishes the Materials Technology Laboratory. Core activities, which will be expanded over the decade, are tailor-made, application-specific materials and innovative technological developments.

In **1996**, staff at Empa's St.Gallen site move into their new building "Im Moos". Core activities are clothing physiology, personal protective systems, functional fibers and textiles, biocompatible materials, materials and image modeling, and technology risk evaluation.

Chronology

In **2001** Empa's priorities are oriented towards research and innovative development. Knowledge transfer and demanding scientific/technical services, remain, however an important part of the Empa portfolio. The organization is restructured into research departments, research programs are initiated and an international Research Commission is established.

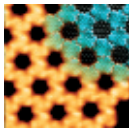
2003 Empa expands its research activities in the field of nanotechnology. The new nanotech@surfaces Laboratory begins working on nanostructures, nanotubes as electron sources, and quasi-crystal layers.

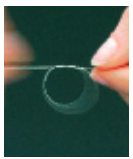
In addition, the Functional Polymers Laboratory is established.

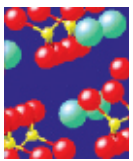
In **2004** yet another Laboratory, Nanoscale Materials Science, is set up in Dubendorf. It focuses on the development and analysis of nanostructured surfaces and coatings.

In **2005** Empa celebrates its 125th Anniversary. On the Open Day some 13 000 guests take the opportunity to pay a visit to Empa.

research
THAT INSPIRES
125
YEARS OF EMPA







In the same year Empa founds the International PhD School Switzerland – Poland together with the Warsaw University of Technology and the AGH University of Science and Technology in Krakow. ETH Zurich, Jagiellonien University in Krakow and Warsaw University have since joined.

Since **2005** more laboratories have been established: Mechanics of Materials & Nanostructures, Mechanical Systems Engineering, Mechanics for Modelling & Simulation, Biomaterials, Materials-Biology Interactions, Hydrogen & Energy, and Solid State Chemistry & Catalysis. Thus, Empa continues to extend its R&D activities in strategically significant areas.

2006 Empa pioneers new ways with the financing of a new research unit. The Center for Synergetic Structures is supported by Empa and Festo Ltd. as a Public-Private Partnership, with the aim of developing novel, ultra light load-bearing structures "made of air".

In **2008** Empa founds glaTec, its business incubator in Dubendorf and

glaTec
Technologiezentrum
an der Empa in Dübendorf

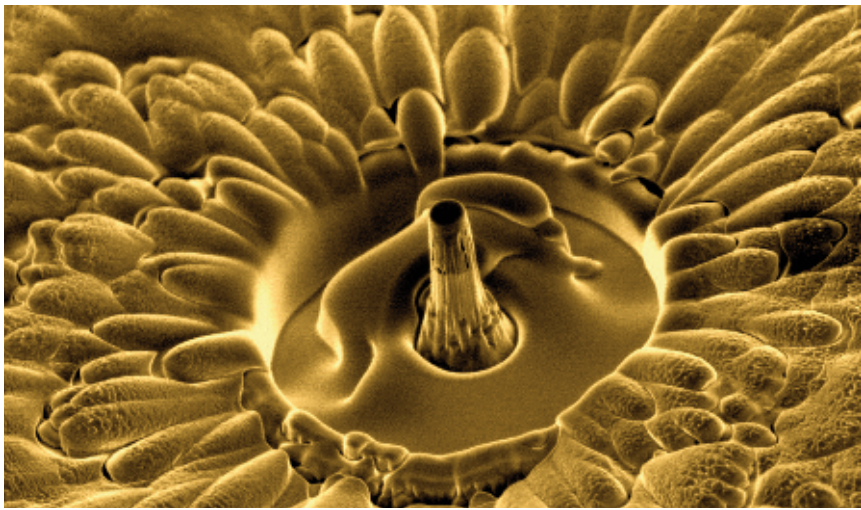
tebo
Technologiezentrum
an der Empa in St.Gallen

counterpart to tebo in St. Gallen, to encourage and support the formation and settlement of innovative high-tech start-ups. The institution also significantly extends its activities in the field of photovoltaics.

Additionally, a "Memorandum of Understanding" is signed with the Japanese National Institute for Materials Science (NIMS). Among other things this provides for the exchange of scientists and for establishing collaborative R&D projects. In **2010** a NIMS office at glaTec is established.

In **2010** Empa is breaking new ground in cooperating with industry. Several strategic partnerships in core areas see the light of day, e.g. on fuel cell development, on innovative medtech applications and on mobility concepts.

In the same year Empa is «streamlining» its research portfolio, replacing its Research Programs with Resarch Focus Areas in order to align activities more closely with its core mission: to transfer research and technologies into marketable innovations.



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As an interdisciplinary research and service institution within the ETH Domain, Empa, the Swiss Federal Laboratories for Materials Science and Technology, conducts cutting-edge materials and technology research. Empa's R&D activities focus on meeting the requirements of industry and the needs of society, and thus link applications-oriented research with the practical implementation of new ideas. As a result, Empa is capable of providing its partners with customized services and solutions that not only enhance their innovative edge and competitiveness, but also help to improve the quality of life for the public at large. Through an efficient technology transfer Empa is turning research results into marketable innovations. As part of the ETH Domain, Empa is committed to excellence in all its activities.