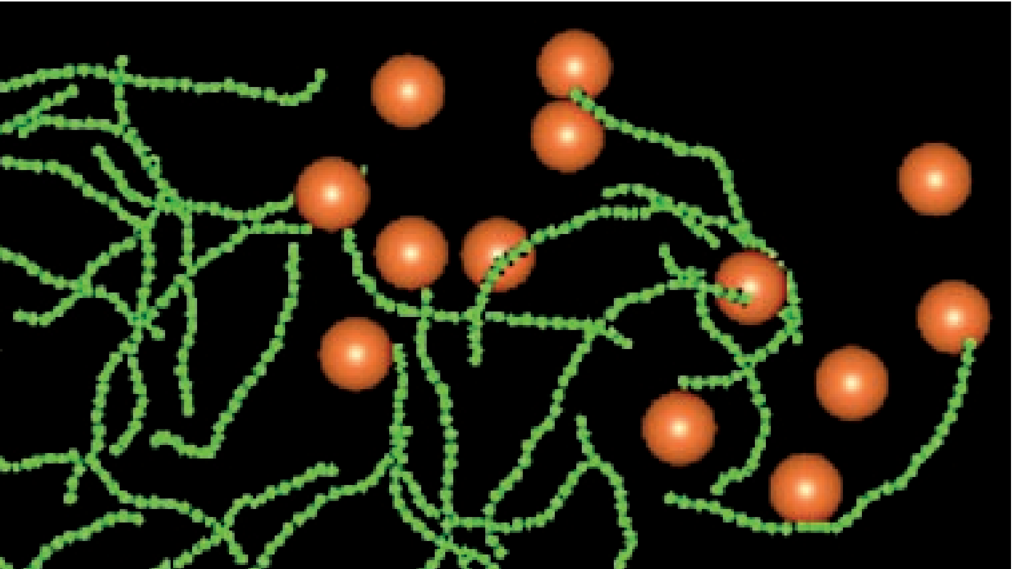
FriMat Fribourg Center for Nanomaterials.



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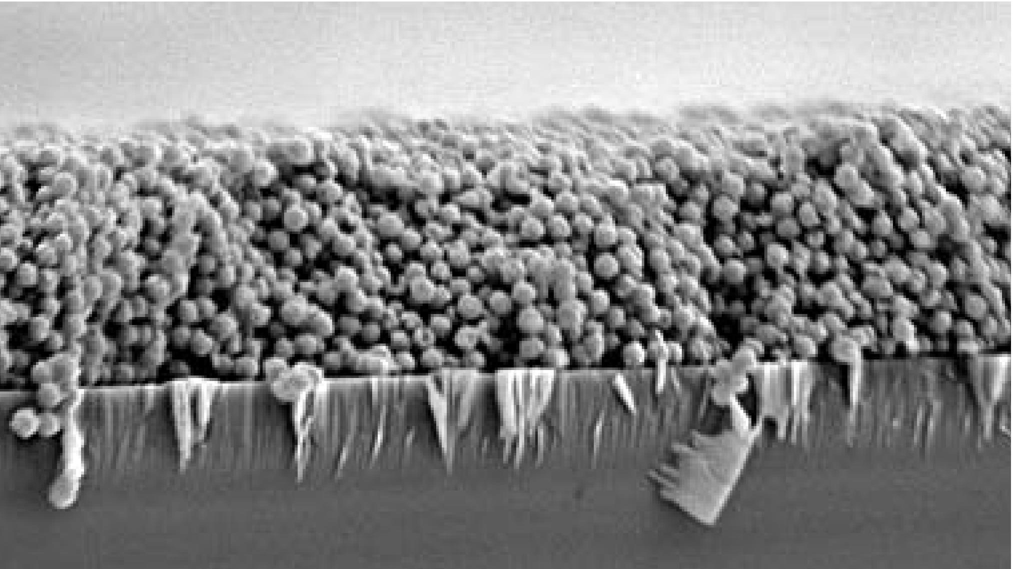

Mission

Nanotechnology is a new arena of science and engineering where structures and materials on the nanoscale are investigated, and where researchers manipulate atoms and molecules in order to create new and smart materials. It is multidisciplinary by definition, and promises to revolutionize the scientific and industrial world in a variety of areas that include high performance materials, environmental sciences, health, food and agricultural products. It is in this exciting and rapidly growing field where the Fribourg Center for Nanomaterials positions its new research activities. FriMat combines a leading fundamental research program on soft condensed matter and solid state physics with an innovative approach to synthesize novel compounds in order to create and study advanced materials. FriMat is determined to not only focus on the creation of novel materials and promote nanotechnology, but investigates into potential risks associated with nanoparticles, and develops new tools essential in any attempt to sample and characterize nanoparticles in the environment. FriMat is committed to transfer its generated knowledge into practice and acts as a connecting link between fundamental physics research and industrial applications. FriMat provides access to its unique experimental facilities and actively promotes long and short term industrial collaborations with international and national partners. FriMat helps to solve scientific and technical problems of small and medium size companies, which do not have the necessary research infrastructure. FriMat has a strong commitment to teaching at all levels, and actively participates in the Materials Science educational programs of the University of Fribourg and the joint activities of the BeNeFri universities Bern, Neuchatel and Fribourg.

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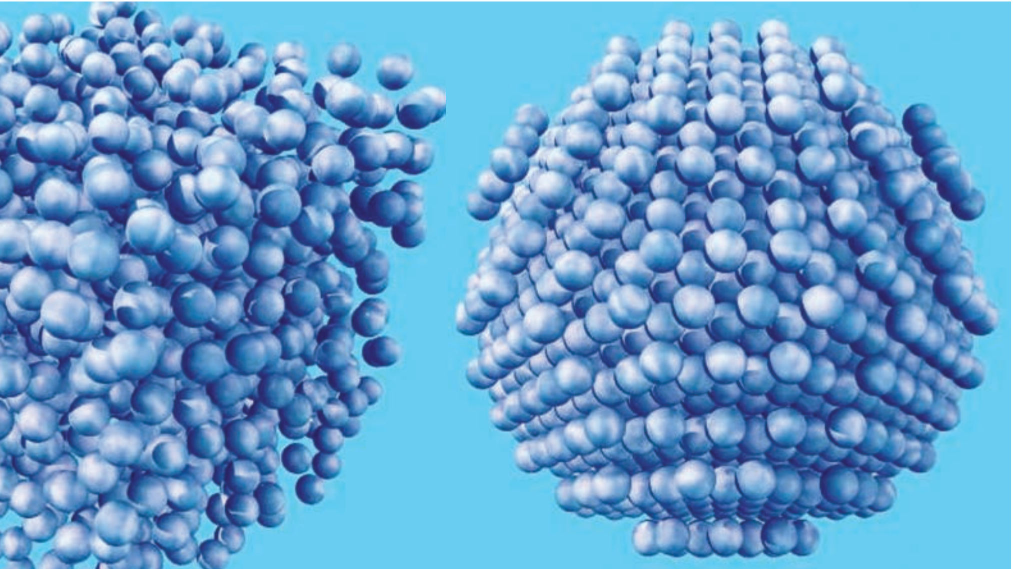

Research Programs

Our research programs are truly multidisciplinary in nature, but based on a rigorous fundamental research activity in soft matter and solid state physics. We are currently active in seven areas of research:

- Soft Nanotechnology
- Self-Assembled Functional Materials
- Photonic Materials
- Nanoscopic Heterostructures from Oxides and Organics
- Hydrogen in Materials
- Ultrafine Particles in the Atmosphere
- Nanocharacterisation of Bulk and Surface Properties

Key questions:

What are the relevant parameters that allow us to control and optimize the stability and the performance of nanocomposites?

How can we learn from nature in order to create intelligent nanomaterials with complex functionality

How can we achieve a completely non-invasive and in-situ characterization of nanomaterials

Prof. Dr. Peter Schurtenberger
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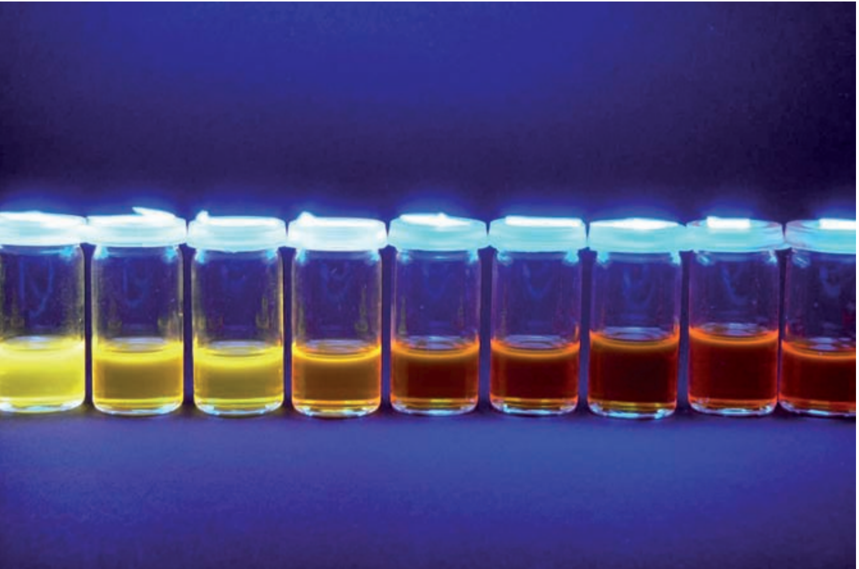
Soft Nanotechnology



The interaction between colloidal particles, their ability to form either highly ordered or amorphous structures, is of fundamental importance for novel applications in areas such as photonics or composite materials. In combination with polymers, hybrid nanocomposites have been developed to combine the advantages of both classes of materials and widen their application range. Here we design functionalized nanoparticles that can be used to create adaptive polymer-colloid nanomaterials with tailored optical and mechanical properties. We investigate nanotechnology applications in areas such as life and food sciences. We also continue to develop tools for a non-invasive nanocharacterization of these complex materials.

Key questions:

How can we design functional materials at different length scales?

What are the key parameters which control the final structure in complex fluids?

How can we tune material functionality and adapt it to a specific problem?

Prof. Dr. Raffaele Mezzenga
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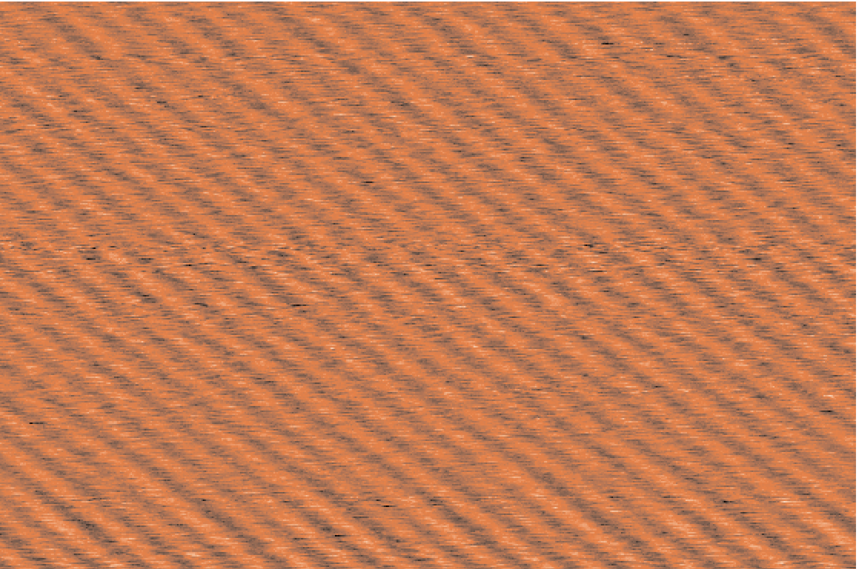

Self-Assembled Functional Materials

Self-organization of natural and synthetic macromolecules into complex structures whose periodicity spans from few up to hundreds of nanometers is a key procedure to design complex functional materials. In this approach, controlling the molecular architecture of the natural or synthetic components used allows tuning the characteristic length scale, and thus physical properties of the functional material, while the chemical nature of the components assesses the material functionality. By using block copolymers, proteins, surfactants, polypeptides, and colloids as building units and exploiting their self-assembly as general design procedure, we can rationalize structures serving in multiple applications as different as optoelectronics and life science.

Key questions:

Do we need perfect photonic crystals or can amorphous photonic materials be used instead?

How can we reach fast and efficient self-assembly of structures with photonic properties?

Which chemical substances are best suited to design photonic materials?

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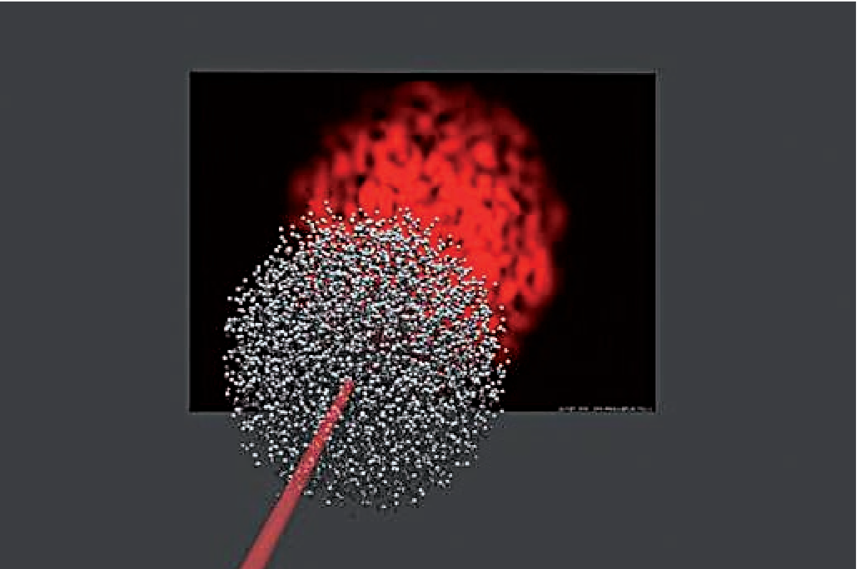
Photonic Materials



Tailoring nano- and mesoscopic order can lead to totally new, so-called photonic properties. At the core of the design of these new materials lies the intelligent way structures are assembled on length scales comparable to the wavelength of light. By tuning the degree of order or disorder we can explore photonic properties in a completely new regime. We have recently demonstrated that short-range-order induced Bragg backscattering resonances can lead to a strong wavelength dependence of the optical transmission. We want to transfer this fundamental optical effect to the design of optical filters and windows that can change reversibly from opaque to clear. Tailoring optical transport properties can also be used to improve light harvesting performance of solar cells.

Key questions:

How to obtain materials with superior physical properties and novel functional capabilities by designing and tailoring nanoscopic heterostructures from solids with competing interactions and orders?

How to apply and further develop experimental techniques that provide in-depth knowledge about the structural, electronic and magnetic properties on the relevant nanometer scale?

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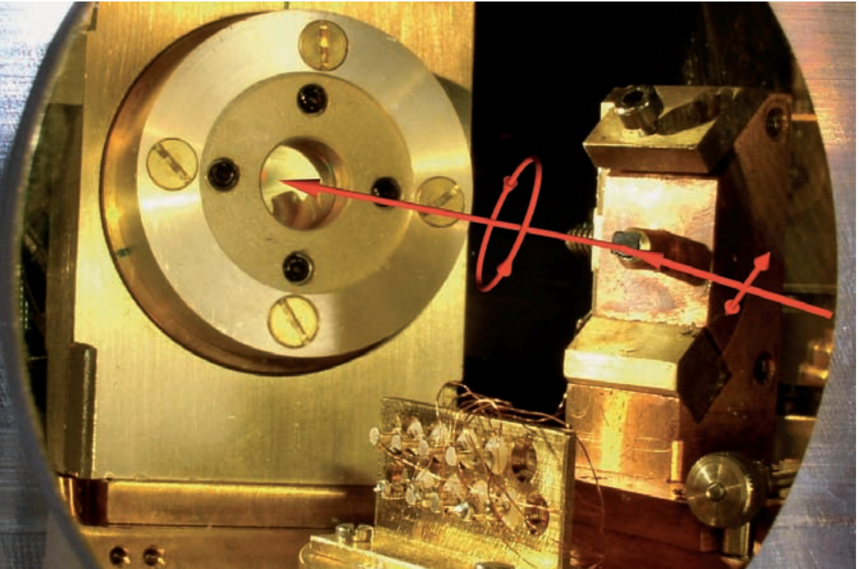
Nanoscopic Heterostructures from Oxides and Organics



Materials with superior physical properties and novel functional capabilities can be obtained by designing and tailoring nanoscopic heterostructures from solid state materials. Well-known examples are silicon based semiconductor heterostructures that form the backbone of today's information processing technology. Our emphasis is on combining modern materials like oxides with strongly correlated electrons or organic conductors and magnets with competing order parameters or strongly spin dependent transport phenomena. Besides the growth of high quality heterostructures, we specialize in devoted spectroscopic techniques that yield the structural, electronic and magnetic properties on the relevant nanometer scale.

Questions we solve for hydrogen in materials:

Which complex hydrides of the p-elements and hydrogen exist?

What are the physical properties of the complex hydrides?

What parameters define the stability of a complex?

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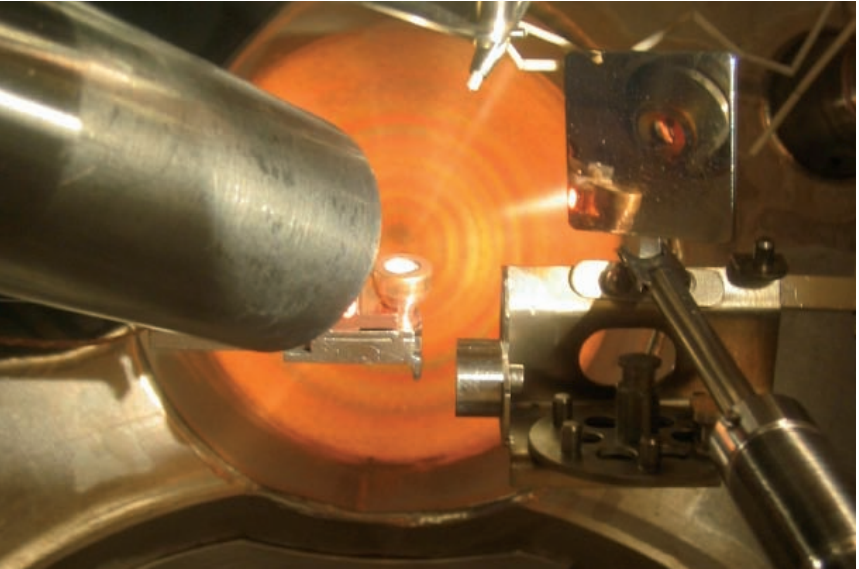
Hydrogen in Materials



Hydrogen as an energy carrier is produced from renewable energy and water and the stored energy is released in an internal combustion engine or a fuel cell. The major challenge is to store hydrogen with a high density in a safe way. The research focuses on the synthesis and investigation of new p-element hydrides. Little is known about the physical properties of the complex hydrides, i.e. their structure, electronic properties and thermodynamics. The goal of the research is to understand the interaction of hydrogen with the p-elements in order to model and calculate the properties of new compounds and to find the theoretical limitations.

Main questions

How can ultrafine, airborne particles be sampled and analyzed?

What is the physical and chemical nature of such ultrafine particles?

What are the sources and transportation mechanisms of such particles?

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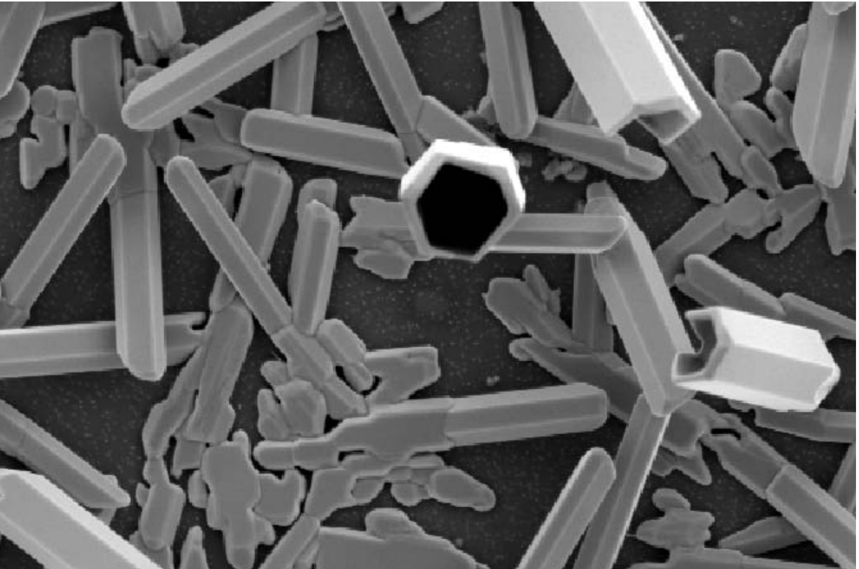
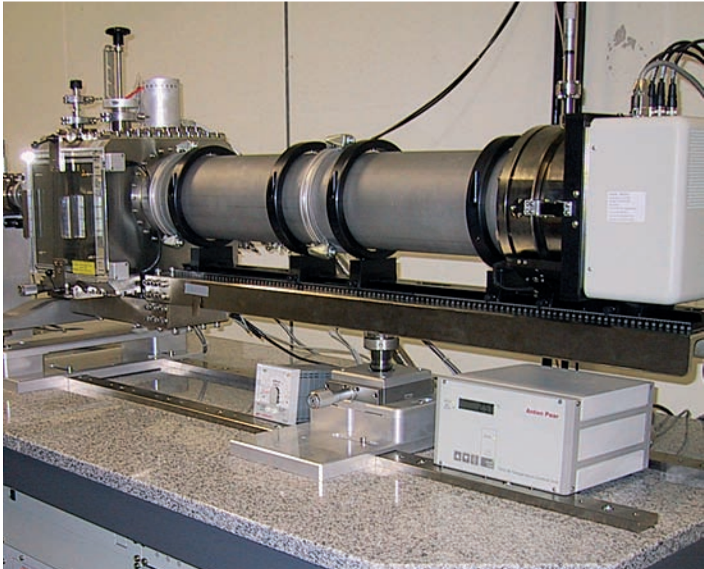
Ultrafine particles in the atmosphere



Fine particles from diverse natural and anthropogenic origins are ubiquitous in the atmosphere. They influence physical processes such as cloud formation and radiation transfer, but are also affecting people's health. Ultrafine particles (< 1mm in diameter) are by far the most important contribution to the number size distribution. It is this fraction, which will also penetrate farthest into the respiratory tract, eventually reaching the lung and other organs. Little is known, however, about their chemical and physical characteristics. Together with the «Air Pollution / Environmental Technology» group of EMPA we try to develop tools to sample and characterize the nanosize fraction of aerosol in order to trace back their sources and to supply basic parameters to understand their toxicology.

Nanocharacterisation of Bulk and Surface Properties



Our unique experimental infrastructure can be applied in the following areas:

Dynamic and structural properties of nanomaterials on a wide range of length and time scales,

nanoparticle synthesis and characterization,

surface microscopy via AFM/STM,

electron microscopy,

electronic and magnetic properties,

nanoscale heterostructures from oxides; organics and hydrides.

Infrastructure:

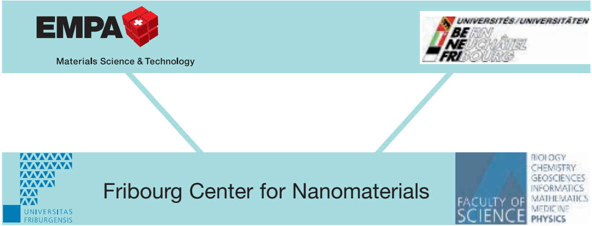
- Static and dynamic light scattering instruments for the characterization of transparent and turbid suspensions, particle sizing, zeta potential etc.
- Characterization of viscoelastic fluids and solids (light scattering, diffusing wave spectroscopy, Rheology)
- Small- and wide-angle X-ray scattering instruments, X-ray diffractometers such as powder X-ray diffractometer equipped with high temperature stage
- Optical video microscopy at rest and under shear
- AFM/STM facilities
- Field Emission Scanning Electron Microscope (SEM) equipped with an Energy Dispersive Spectrometer (EDS) and an Electron Backscatter Diffraction (EBSD) system.
- Ultra high vacuum annealing columns coupled with high electric DC field.
- Ultra high vacuum pulsed laser deposition (UHV-PLD) system with high pressure RHEED system, UHV transfer system and sputtering chambers.
- Broadband ellipsometry spectrometers, far-infrared to deep ultraviolet (2 meV to 6.5 eV, 2 to 800 K).
- High resolution magnetometry and (magneto)transport measurements (1.5 to 350 K, 0-9 Tesla).

We provide access to our facilities via short and long term projects with private and public partners.
Additional information can be obtained from info@frimat.ch

Organisation

Prof. A. Züttel, Prof. H. Hug

Advanced Materials
Dr. P. Gröning



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