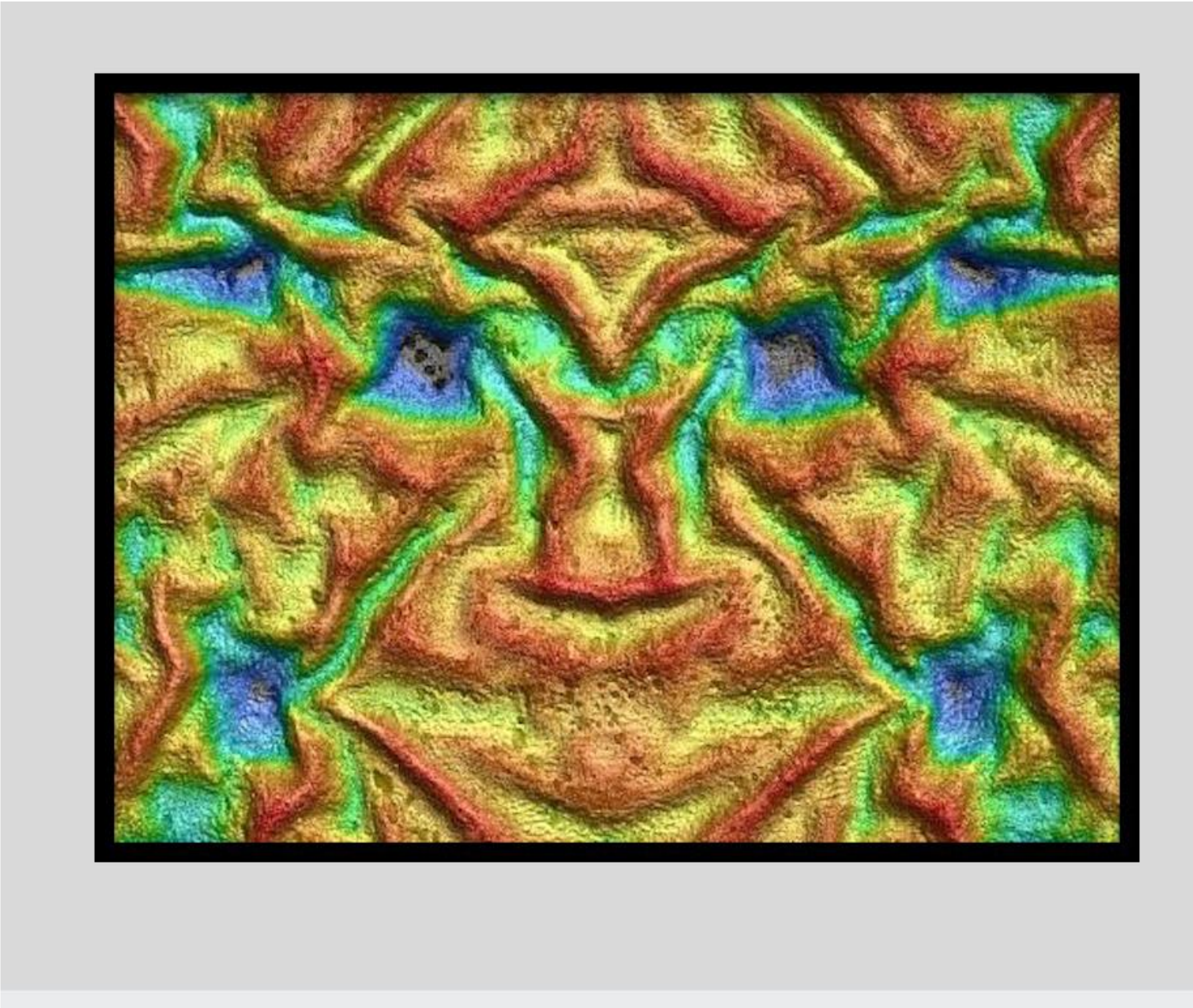
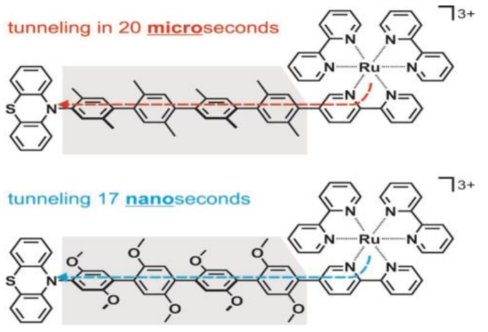
Kursbeschreibung Blockkurse 2022/2023



INKA Maske Konfokales Laser-Scanning-Mikroskopie-Bild eines Lacks auf einer PET-Folie, abgeformt von einer laserstrukturierten Stahlvorlage Maßstab: 280 µm x 210 µm x 16 µm Das Bild ist das Ergebnis einer Zusammenarbeit zwischen der ALPS (Berner Fachhochschule) und INKA, FHNW Dr. Laurent Feuz Institut für Nanotechnische Kunststoffanwendungen (INKA), FHNW

Inhalt

A. Zeitdauer 3 Wochen, nachmittags, 3 KP pro Kurs



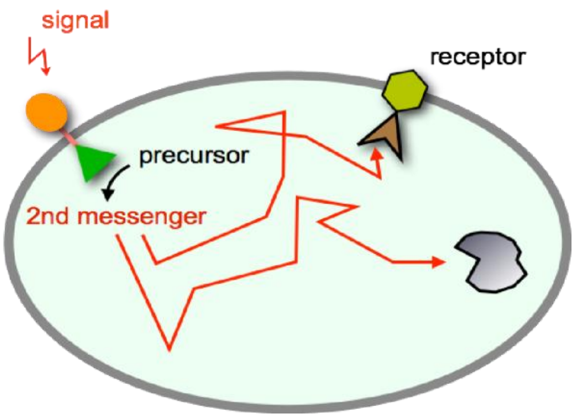
1. Koordinationschemie
O.Wenger

Pro Kurs 1 Student

Dieser Blockkurs baut auf dem Praktikum Organische Chemie auf. In mehreren Etappen wird ein organischer Ligand hergestellt, der an ein Metall koordinieren kann. Nebst der praktischen Synthesearbeit sind die chromatographische Reinigung und die Analyse der hergestellten Liganden und Koordinationsverbindungen wichtige Aspekte dieses Blockkurses. Das metallhaltige Zielmolekül ist jeweils Teil eines aktuellen Forschungsvorhabens der Arbeitsgruppe Wenger und gehört in der Regel zu einem der folgenden Themengebiete:

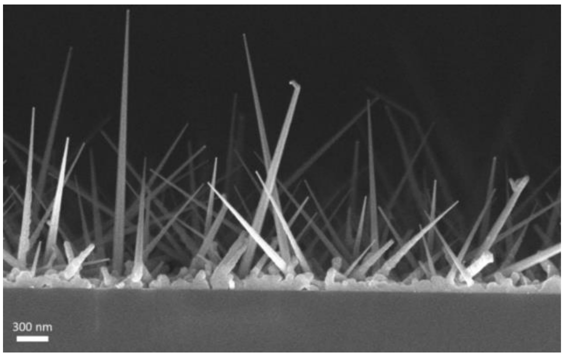
- Künstliche Photosynthese
- Photochemie
- Photolumineszenz
- Lichtinduzierter Elektronentransfer

Ausführlichere Informationen zu den einzelnen Themengebieten sind auf der Homepage der Arbeitsgruppe Wenger (http://www.chemie.unibas.ch/~wenger/research.html) zu finden.



2.1 Synthesis of nanostructured materials
Ilaria Zardo

Pro Kurs 2 or 3 persons



Nanostructures have been extensively investigated in the last two decades as model systems for exploring the role of dimensionality and size in the electronic, mechanical, and optical properties of nanomaterials. Semiconductor nanowires (NWs) and thin films play a crucial role both for fundamental physics studies and for potential technological applications.
The most commonly used method for the synthesis of NWs from the gas phase is the catalyst-mediated Vapor Liquid Solid (VLS) method. In this technique, a metal seed is used as catalyst for the growth of NWs from a gas precursor. Gas-phase epitaxial synthesis not only results in NWs with high crystalline quality, but also allows

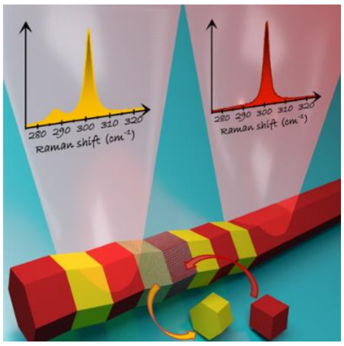
controlling the NW length, diameter, radial and axial composition, and crystallographic structure. In our laboratories we have two (Plasma Enhanced) Chemical Vapor Deposition (CVD) systems, which enable us to synthesize Silicon and Germanium nanostructures as well as SiN_x and SiO_x thin films.

In this course you will learn how to operate a CVD system and prepare the substrate for nanostructures synthesis. Furthermore, the morphology of the obtained samples will be investigated by means of Scanning Electron Microscopy.

2.2 Spectroscopy of Phonons

Ilaria Zardo

Pro Kurs 2 or 3 persons



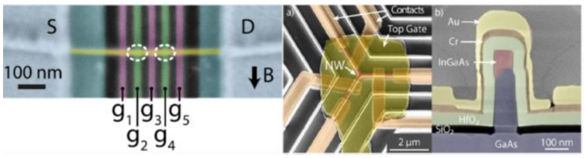
Phonons, which are quantized vibrations of atoms in crystals, are responsible for the transmission of sound and heat. Therefore, the capability to engineer phonons in condensed matter corresponds to the capability to tune the sonic and thermal properties of materials with applications such as medical ultrasound imaging machines, thermal insulation materials, thin acoustic metamaterials that can soundproof rooms, and enhanced thermoelectric devices that can use our bodies' waste heat to power portable electronic devices. Two ingredients are typically used to design the phononic properties of materials: i. The size of the structures and ii. The combination of different materials with different elastic properties.

Inelastic light scattering spectroscopy enables the determination of lattice dynamics, chemical composition, strain level, and some electronic properties of semiconductors, including nanowires.

In this course you will learn the physics of phonons, how to perform both spectroscopy experiments and the analysis of the experimental data.

Quantum Coherence Lab

D.Zumbühl

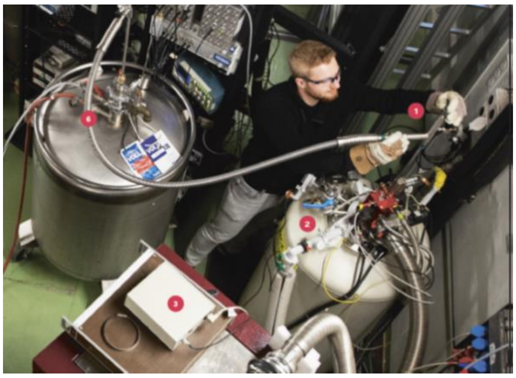


3.1 Semiconductor Nanofabrication Course

(groups of min. 2, max. 3 persons)

Over the past five decades, transistors made from semiconductors – Silicon, in particular – were scaled down to a size of only a few nanometers, allowing the integration of billions of transistors and thus bits on a single square centimeter chip. This has made possible today's computers and the information technology revolution. Today, we are working on using this same transistor technology for the development of quantum bits, or so called qubits, for quantum information processing. A quantum computer would take advantage of some of the resources of quantum mechanics which are not available in classical physics, such as quantum superposition and quantum entanglement. This would give great computational power to the quantum computer, allowing to solve problems which are otherwise intractable. The goal of this course is to provide insight and training of device fabrication for semiconductor nanostructures: you will fabricate a semiconductor sample – from the bare wafer to the completed sample – in our in-house clean room. This includes a number of different clean room processing steps such as etching, resist spinning, lithography, thin film deposition, contact definition, surface gating and wire bonding. The same methods are also used for sample fabrication in ongoing research in our group. Finally, you will perform some electrical characterization of the sample in the cryolab at room temperature and 4.2 K in liquid helium

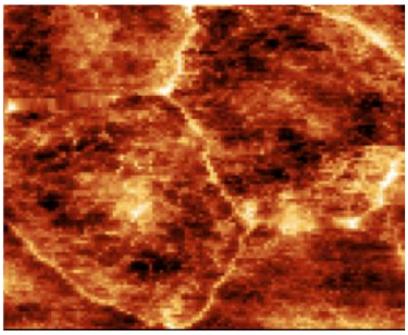
3.2 Quantum transport experiments
Cryo-Lab Measurement Course
(groups of min. 2, max. 3 persons)



Recommended prerequisite for this course: KoMa and Quantum Mechanics. Ideally, but not necessarily, the Spin Qubit Nanofabrication Course is taken first, then subsequently the cryo-lab measurement course.
Quantum transport is the study of quantum phenomena probed with electrical means, typically using nanoscale devices at low, cryogenic temperatures. Conductance quantization and the quantum Hall effect are some of the most striking and beautiful phenomena discovered in quantum transport experiments. Further, spin qubits for quantum computation are currently being developed with quantum transport techniques. In this course, you will study one of these phenomena (or a similar quantum effect) in our cryo lab. With the guidance of a teaching assistant, you will cool down a device to milli-Kelvin temperatures in a dilution refrigerator (evaporative cooling of a superfluid 3He/4He mixture). You will use low-noise electrical techniques and superconducting magnets to investigate the quantum physics. We will provide the samples for the experiments. (In the Semiconductor Nanofabrication course, you can learn most of the steps required to fabricate such devices).

Visit https://Zumbuhllab.unibas.ch for further information

4. Methods in Nanobiology
R.Lim
Pro Kurs 6 Studierende

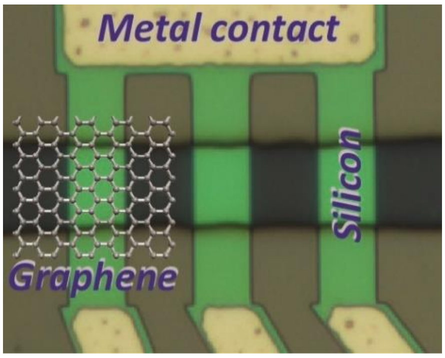


Nanobiology attempts to resolve biological function from the “bottom-up”. Our research interests include nucleocytoplasmic transport control, its role in regulating cell and tissue mechanobiology, and how this phenomenon can be leveraged towards bio-inspired applications. Very often, our questions motivate us to develop new methodologies, which we combine in a multidisciplinary manner to be able to correlate different perspectives of a certain biological problem. In this Blockcourse, you will not only gain first-hand experience on the use of such cutting-edge instrumentation, but will more importantly learn how to ask biological questions from a nanoscience perspective. Ongoing projects include: studying the mechanobiology of cells and tissues using indentation-based atomic force microscopy (see Figure) and fluorescence microscopy, (ii) applying high-speed atomic force microscopy to visualize native nuclear pore complexes at work (iii) building artificial nanopores to study transport processes at the single molecule level.

5. Biointerfacing materials
C. Palivan, A. Dinu
Per course: 2 students

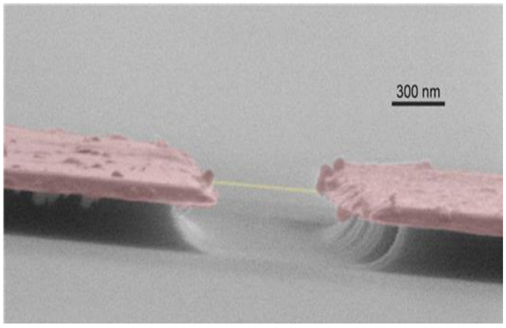
In this block course, the students will get an introduction into the formation of various polymer supramolecular assemblies, ranging from three-dimensional colloidal structures in aqueous solution to planar polymer membranes on solid supports, as well their characterization by combinations of physical-chemistry methods. We are interested to turn these synthetic assemblies at nano- and micro-scale into advanced functional materials by equipping them with a variety of biomolecules including proteins, peptides, and nucleic acids. To achieve this, we will encapsulate/insert specific biomolecules within the polymer assemblies or attach them on the polymer surface by different bioconjugation techniques. These colloidal bio-polymer systems gain unique properties due to the intrinsic specificity of the building blocks (amphiphilic copolymers and biomolecules) and are applied as novel functional materials in bioengineering, biosensing and medicine.

6. Nanolithographie
Ch. Schönenberger
Pro Kurs min. 2 und max. 3 Studierende



Integrierte Schaltkreise (sog. IC's) werden mittels Lithographieverfahren in Silizium gefertigt. Strukturen (z.B. metallische Leiterbahnen, Transistoren) werden mit Abmessungen im Submikrometerbereich gefertigt (Nanolithographie). In der Forschung versuchen wir, möglichst kleine Strukturen an der Grenze des Machbaren zu erzeugen und deren Eigenschaften zu charakterisieren. Dieser Kurs soll einen Einblick in diese Strukturverfahren vermitteln. Es wird versucht, Sie während den drei Wochen in ein laufendes Projekt zu integrieren. Dabei werden Sie mit folgenden Verfahren (Apparaturen) in Berührung kommen: Belackung von Si-Substraten; Bestimmung der Schichtdicke; optische- und/oder Elektronenstrahl Lithographie; Plasmaätzen (subtraktives Verfahren); Aufdampfen von Metallschichten und lift-off Prozess (additives Verfahren); Rasterelektronenmikroskopie.
Voraussetzungen: Der vorgängige Besuch des Mikroskopiekurses ist wünschenswert.

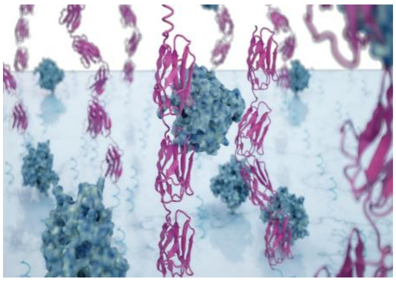
7. Nanophysics: Low-dimensional conductors
Ch. Schönenberger
Pro Kurs min. 2 und max. 3 Studierende



Ein klassischer Kupferdraht ist für die Elektronen, die für den Ladungstransport sorgen, etwas Dreidimensionales. Wenn der Draht kleiner und kleiner wird, findet ein Übergang in der Dimensionalität statt. Es gibt dann 2-dimensionale und eindimensionale Drähte und im Prinzip sogar null-dimensionale Systeme. In diesem Blockkurs legen wir den Schwerpunkt auf niedrig-dimensionale Materialien, die in neuartigen Wachstumsverfahren gewonnen werden, wie z.B.: Kohlenstoff Nanoröhrchen, halbleitende Nanodrähte oder Graphene (eine Monoschicht von Graphite). Bei den Kohlenstoff Nanoröhrchen haben die kleinsten einen Durchmesser von nur einem Nanometer und können dennoch in makroskopischer Länge gewachsen werden. Diese Röhren weisen beeindruckende Eigenschaften auf: mechanisch sind sie vergleichbar widerstandsfähig wie Diamant; elektrisch können sie den Strom leiten wie kein anderer Draht mit vergleichbaren Abmessungen. Abhängig von den gerade bestehenden Forschungsaktivitäten wird das Ziel des Kurses jedes Jahr neu fixiert. Wir werden versuchen, eine aktuelle Fragestellung zu bearbeiten.

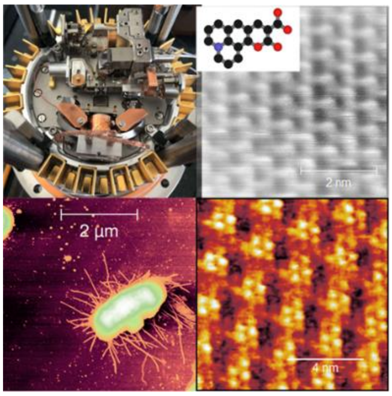
Voraussetzung: Kondensierte Materie/ Mikroskopiekurs/Nanolithographie vorgängig werden empfohlen.

8. Biomolecular Engineering
M. Nash
Pro Kurs 1 Studierende



In this practical block course, the students will get experience in the entire workflow for producing, purifying, and characterizing engineered proteins. We are interested in developing engineered proteins for therapeutic purposes. To achieve this, we will introduce the students to molecular cloning of synthetic DNA fragments, transformation and gene expression, as well as protein purification. We will introduce them to genetic library generation and high-throughput screening of clones for enhanced phenotypic traits such as stable binding interactions or enzymatic catalysis.

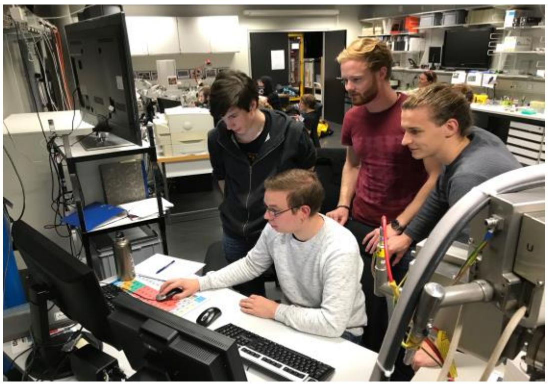
9. Scanning Probe Microscopy
E. Meyer/T.Glatzel
Pro Kurs 4 Studierende



Atomic Force Microscopy (AFM) is nowadays established as a powerful tool being able to determine a large variety of samples properties. The technique is commonly used in many physics, chemistry and biology laboratories. AFM is operating in several dynamic and static modes and in various environments, namely vacuum, ambient and liquid. Thus, it allows to obtain informations about surface topography, surface chemical composition, sample elasticity, frictional behaviour, electrical charge localization, contact potential, magnetic domains behaviour and many more.
Within the Blockkurs recent progress in the field of Scanning Probe Microscopy is discussed and relevant experiments are performed. The students will have opportunity to learn various Atomic Force Microscopy (AFM) techniques. The main focus is put on dynamic modes, which allow to study surfaces in a minimally invasive way. The various microscopes allow to study metallic, insulating, organic and biological samples under ambient, liquid and ultra high vacuum conditions. Sample surface might be investigated down to the atomic scale, which in turn allows to determine the defect densities, the structure of molecular self-assembled networks or the behaviour of charge density wave (CDW) systems. In ambient or liquid environments AFM could characterise the mechanical or electric properties of

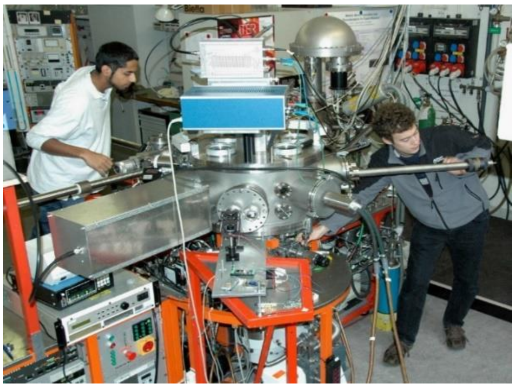
polymer structures or even the bacteria cell. During the training the students will also obtain knowledge about various sample preparation techniques.

10. Mikroskopie mit Schwerpunkt Raster-Elektronenmikroskopie
M. Dürrenberger
Pro Kurs 9 Studierende



Wir möchten Ihnen die Abbildung der Mikro- und Nanowelt vermitteln. Der Kurs beinhaltet eine Einführung in die Konfokale Lasermikroskopie, in die Transmission Elektronenmikroskopie und einen Einblick in die Arbeit mit dem FIB (Focused Ion Beam) an einem dual Beam FIB / SEM Mikroskop. Als Ziel dieses Kurses erhalten Sie eine solide Grundausbildung im Umgang Raster-Elektronenmikroskopen (Theorie und Praxis). Der Schwerpunkt dieses Kurses liegt in der selbständigen Bedienung unserer Raster-Elektronenmikroskope. Sie werden in kleinen Gruppen am Raster-elektronenmikroskop nach Anleitung arbeiten. Dies beinhaltet mehrere Basis-Präparationsarten, die Bedienung der Geräte und die Abbildung mit EDX von Präparaten. Ihre Fähigkeiten werden Sie in einer praktischen Prüfung mit abschliessendem schriftlichen Bericht nachweisen, welcher benotet wird.
Zur Beachtung: Dieser Kurs wird als Vorbildung zum Kurs Nr.6 „Nanollithographie“ und Kurs Nr. 7 „Nanophysics“ empfohlen.

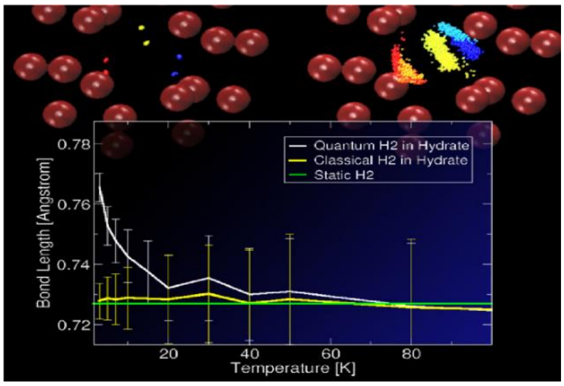
11. Nanomaterialien and Elektronenspektoskopie
E.Meyer/ Laurent Marot
Pro Kurs 2 Studierende



Im Rahmen dieses Blockkurses werden plasmagestützte Techniken angewendet, um nanostrukturierte Materialien herzustellen. Die abgeschiedenen Materialien werden in-situ bezüglich ihrer Zusammensetzung und ihres chemischen Aufbaus mit Photoelektronenspektroskopie (PES) charakterisiert.
<u>Kursthemen:</u>
Schichtabscheidung: Methoden der vakuumgestützten Schichtabscheidung, plasmagestützte CVD («chemical vapor deposition»), Abscheidung, Magnetronsputtering, kombinierte Methoden zur Herstellung nanostrukturierter Materialien, Ausblick auf andere Schichtabscheidungsmethoden.
Prozessüberwachung: in-situ, ‹real-time› Überwachung der Schichtabscheidung mit Reflektometrie.
Photoelektronenspektroskopie: allgemeine Grundlagen der PES (Mechanismus, einfache Modelle, Anwendung der PES), Bestimmung der chemischen Zusammensetzung von Schichten mit in-situ Röntgen-Photoelektronenspektro-skopie (XPS) und Ultraviolett

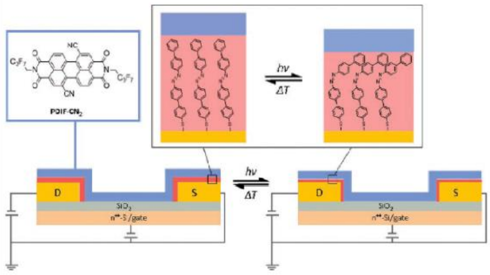
Photoelektronenspektroskopie (UPS), Identifizierung von chemischen Bindungen, Methoden zur Bestimmung der Nanostrukturvon materialien. *Allgemeine Schichtcharakterisierung:* Schichtdickenmessung durch Profilometrie und Vergleich mit optischen Methoden, Untersuchung der Schichttopographie mit Rasterelektronenmikroskopie und Rastersensormethoden.

12. Atomistische Simulationen
M. Meuwly
Pro Kurs 2 Studierende



Dieser Blockkurs gibt Einblick in die Durchführung und Analyse von Molekular-Dynamik Simulationen mit spezifischen Anwendungen auf Fragestellungen der kondensierten Materie. Mögliche Themen beinhalten die Untersuchung von Proton-Transfer Reaktionen, das dynamische Verhalten von Wassermolekülen in räumlich einschränkenden Umgebungen (Proteine, Buckyballs, Nanotubes), oder die Bestimmung des Infrarot Spektrums von kleinen Liganden in Myoglobin. Für die meisten Simulationen verwenden wir eine QM/MM (quantum/ classical force field) Methode zur Beschreibung der elektronischen Struktur. Im Vordergrund der Rechnungen steht dabei, experimentell zugängliche Groessen mittels MD Simulationen zu bestimmen. Das Thema des Blockkurses wird mit den Teilnehmenden in einer kurzen Besprechung einige Tage vor Beginn des Kurses festgelegt. Weitere Themen (z. B. mehr biologisch orientiert) koennen auf Wunsch hingefunden werden. Programmierkenntnisse sind nicht noetig. Es lassen sich jedoch auch Themen finden, welche explizit die Programmierung in C++, Fortran, perl oder python erfordern. Weitere Informationen und Beispiele aus frueheren Blockkursen finden Sie unter www.chemie.unibas.ch/~meuwly/mdnano.block.html

13. Nanochemistry
M. Mayor
Pro Kurs 1 Studierende/r



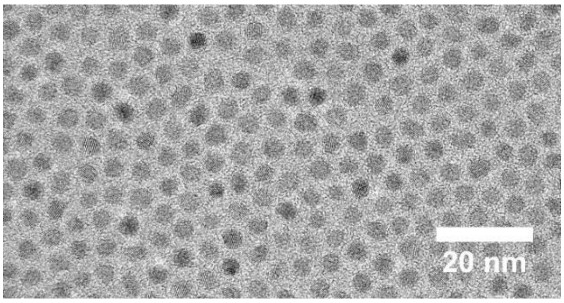
Schematic representation of the device structure showing the reversible isomerization reaction (trans–cis) that takes place at the interface between the semiconductor and AZO-functionalized electrodes.

In diesem Blockkurs werden die Kenntnisse des Praktikums Organische Chemie vertieft. Wir geben einen Einblick in die praktische Arbeit des Synthese-Chemikers. In mehreren Schritten wird ein Zielmolekül synthetisiert. Neben der Synthese steht auch die Isolierung, Analyse und vorherige Planung der Arbeit im Fokus. Das Zielmolekül ist jeweils Teil eines aktuellen Forschungsprojektes der Arbeitsgruppe Mayor und kann einem der folgenden Forschungsbereiche zugeordnet werden: Molekulare Elektronik, Gezielte Funktionalisierung von Oberflächen (siehe Bild), Quanten-Eigenschaften von organischen Molekülen, Molekulare Textilien, Chirale Moleküle und deren optische Eigenschaften. Genauere Information zu den einzelnen Bereichen,

können auf der Homepage nachgelesen werden:
https://mayor.chemie.unibas.ch/en/

14. Colloidal nanocrystals
J. De Roo

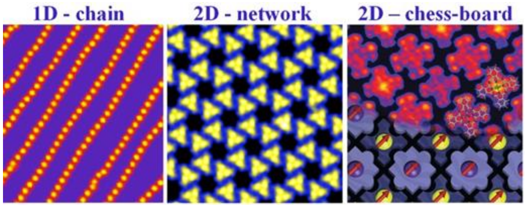
Pro Kurs 1 Studierende



Colloidal nanocrystals and atomically precise nanoclusters are excellent building blocks for nanotechnology. We aim at their application in novel memory devices, medical contrast agents or LEDs. In this course you can learn about the various aspects of these fascinating materials. Controlling the size, composition and structure of colloidal nanocrystals is still a challenge, one that we tackle using controlled precursor chemistry and mechanistic analysis. We also offer training in analyzing the surface chemistry using NMR spectroscopy or in analyzing the core using x-ray scattering methods.

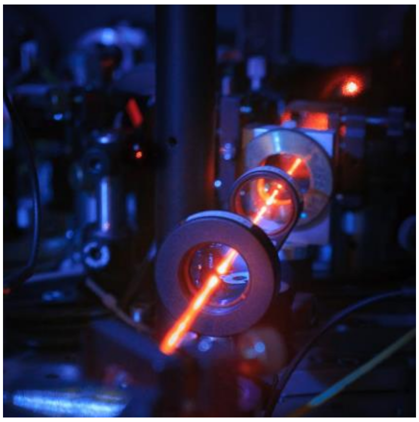
https://deroo.chemie.unibas.ch/en/home/

15. Nanolab: Physik und Chemie am einzelnen Atom oder Molekül
T. A. Jung
Pro Kurs 6 Studierende (Intensivkurs ' nach flexibler Absprache`)



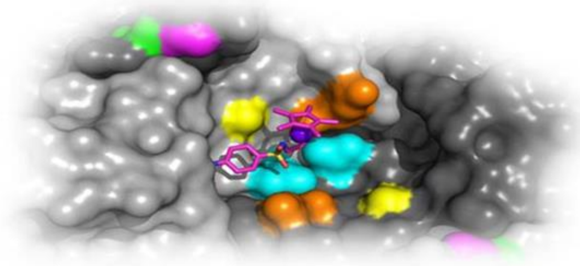
Anhand eines aktuellen Forschungs-projektes wird selbständig mit Ober-flächenphysikalischen und Oberfläch-en chemischen Präparationstechniken, Instrumenten und Charakterisierungs-techniken gearbeitet. Die Blockkurs-teilnehmer werden ins die Forschungs-arbeit des Teams integriert. Mehr -heitlich haben Projekte Bezug zur Grundlagenforschung, aber auch anwendungsnahe Projekte in Zusam-menarbeit mit Firmen (Roche, Glas Trösch, Ferrovac und ABB) stehen für Interessierte zur Verfügung. Zwei Fragestellungen stehen im Vordergrund:
1.) Die Erzeugung von Polymer-architekturen durch eine Kombination von Supramolekularer Chemie, Koordi-nationschemie und Kovalenter Chemie an Oberflächen.
2.) Das Studium der Eigenschaften von Elektronen, Spin und einzelnen Atomen oder Molekülen innerhalb dieser molekularen Architekturen und der Architekturen als ganzem.
1-3 Studierende pro Block, am besten 2. Zeitfenster nach Absprache, auch während den Semesterferien möglich.
http://nanolab.unibas.ch/
E-mail: thomas.jung@psi.ch

20. Quantum optics and atomic physics
Philipp Treutlein
1 course with 3 students



Atoms are quantum systems par excellence, and the laser manipulation of the quantum state of atoms has led to many scientific and technological breakthroughs. This includes the observation of Bose-Einstein condensation, the development of atomic clocks and atomic precision sensors, and experiments on quantum information processing and quantum technology. In this course, you will learn some basic experimental techniques that are used in many modern atomic physics and quantum optics laboratories. For example, you will operate an external-cavity diode laser, learn how to frequency-lock such a laser to an atomic resonance, and perform some basic experiments with it. In the second part of the course, you will have a chance to get some hands-on experience on a more advanced laser setup, closely guided by one of the researchers in the group. The specific topic will be individually defined every year. Possible topics include laser cooling of atoms in a magneto-optical trap, optomechanics experiments with a nanomechanical membrane, and studies of coherent spin dynamics in a microfabricated atomic vapor cell. Prerequisites for the course: basic knowledge of optics, atomic and quantum physics.

21. Engineering protein-hosts for transition metal catalysts
Thomas R. Ward
Pro Kurs 1 Studierende



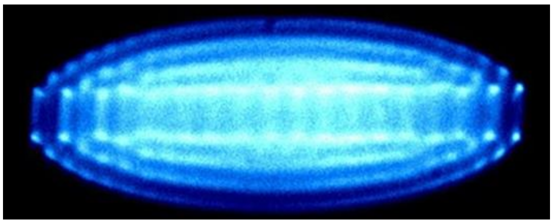
Die Derivatisierung von Übergangsmetall-komplexen mit Gruppen, die mit hoher Affinität an Gastproteine binden, ermöglicht die spezifische Lokalisierung katalytischer Komplexe in Proteingerüsten. Durch Mutation der Proteinhüllen kann die Funktionalität der Metallkomplexe massgeblich beeinflusst werden. Der Kurs bietet die Möglichkeit eines Einblicks in:
1) molekularbiologische Arbeitsweisen
2) die Synthese von Übergangsmetall-komplexen und relevanten Substraten die Durchführung von Katalyseexperimenten mit Protein-basierten Hybridkatalysatoren analytische Techniken für die Reaktionskontrolle und die Bestimmung von Affinitäten, Umsätzen, Enantiomeren-überschüssen und Reaktions-geschwindigkeiten (HPLC, UPLC-MS, GC, UV-Absorption, Fluoreszenzintensität) die Visualisierung der Konstrukte basierend auf Röntgenstrukturen mit z.B. pymol®. Die Teilnehmer werden zusammen mit Mitgliedern der Arbeitsgruppe Ward auf aktuellen Projekten arbeiten. Die Behandlung der aufgelisteten Punkte im Rahmen des Praktikums hängt vom individuellen Projekt ab.

24. Nanoreaktionskammern
Konrad Tiefenbacher
Pro Kurs max. 1 Studierende

Für diesen Blockkurs ist ein hohes Interesse an synthetischer organischer Chemie (Praktikum Organische Chemie) notwendig. In diesem Kurs wird ein aktuelles Thema im Bereich von organischen Nanoreaktionskammern bearbeitet. Nanoreaktionskammern sind molekulare Strukturen im Nanometerbereich, die einen Hohlraum besitzen und Substrate in dieser Kavität einschließen können. Durch nicht-kovalente Wechselwirkungen des Substrates mit der Nanoreaktionskammer können Reaktionen beschleunigt werden bzw. Selektivitäten moduliert werden. Dadurch kann es gelingen die Funktionsweise von natürlichen Enzymen mittels deutlich einfacher Strukturen nachzuahmen. Im Rahmen des Blockkurses gewinnt man Einblick in die Synthese von Nanoreaktionskammern und geeigneter Substrate. Neben der Synthese spielt auch die chromatographische Aufreinigung und die Analyse der Verbindungen eine wichtige Rolle. In dem Kurs wird eines der folgenden Themen bearbeitet:
-Selbstassemblierte Nanoreaktionskammern
- Kovalente Nanoreaktionskammern
-Untersuchung von Reaktionen mit kationischen Übergangszuständen
- Untersuchung von Reaktionen mit anionischen Übergangszuständen

Zusätzliche Informationen zu dem Thema sind auf der Homepage der Arbeitsgruppe Tiefenbacher zu finden: https://nanocat.chemie.unibas.ch/en/

27. Ultracold Ions
Stefan Willitsch
1 course with 2 students

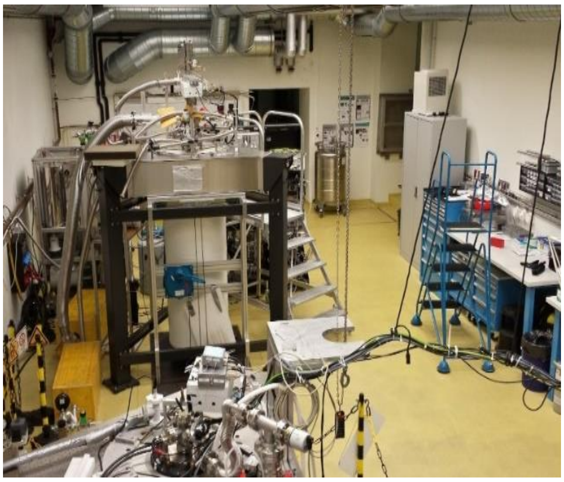


Atomic and molecular ions stored in electrodynamic traps at temperatures close to the absolute zero point exhibit unusual properties. At these low tempera- tures, the ions localize in space so that they can be individually observed, addressed and manipulated. These intriguing features pave the way for a range of diverse and exciting applications such as the stu- dy of chemical reactions with single molecules, the development of quantum computers and the extremely precise measurement of molecular properties.
In this course you will learn to use methods such as laser cooling to cool ions down to temperatures of a few millikelvin and to store them in ultrahigh vacuum using ion traps. You will study the properties of the ultracold ions and explore some of their applications. The specific topics of the course will be closely alig- ned with the ongoing research in the group and will be individually defined every year according to the current research projects.

32. Measurement Control and Acquisition

Martino Poggio

Pro Kurs min . 2 and max. 4 students



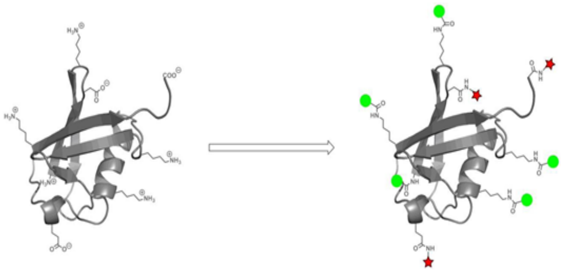
The purpose of this course is to teach students the practical aspects of measurement, control and data acquisition. These are critical components of any modern experiment, especially in experimental physics laboratories. The technological development in the recent years made equipment such as microcontrollers, computers and sensors available for the mass market, that are designed for do-it- yourself experiments that can be taken out at home. This allows to do typical lab tasks with equipment that is accessible to everybody, which is why the single-board computer Raspberry Pi and Arduino microcontroller boards are used in this course. Subjects such as analog-to-digital conversion, sensor read-out, robotics and aspects of control theory in form of a PID loop will be addressed.

A major part of the course is to get basic knowledge in the programming language Python, which will be used to perform the tasks and experiments in the course. Python is a high-level programming language, comparably easy to learn and widely used in the scientific community, and hence its mastery is a very useful skill for anyone interested in working in an experimental physics laboratory.

33. Altering protein and peptide properties by chemical modification

Valentin Köhler/ Marcel Mayor

Pro Kurs 1 Student



Proteinen können ganz allgemein durch ihre chemische Modifikation zusätzliche Eigenschaften verliehen werden, während gleichzeitig ihre natürlichen Eigenschaften verändert werden. Obwohl die Wahl der einführbaren Funktionen in erster Linie nur durch die Fantasie des Forschenden beschränkt ist, sind Proteinmodifikationen trotz etablierter Methoden nicht trivial. Gründe hierfür liegen in dem hohen natürlichen Funktionalisierungsgrad der Oberfläche von Proteinen, der unterschiedlichen Umgebung identischer funktioneller Gruppen, sowie in der Schwierigkeit Reaktionsbedingungen zu finden unter denen beide Reaktionspartner sowohl ausreichend stabil als auch reaktiv sind. Der Kurs ist in ein laufendes Forschungsprojekt eingebunden in dem wir versuchen den Ladungszustand von Proteinen und Peptiden in der Gasphase durch gezielte Photospaltung von speziell eingeführten Gruppen zu kontrollieren. Die physikalischen Untersuchungen, deren Ziel Quanten- Interferenzexperimente an Biomakromolekülen sind, werden von einer befreundeten Forschungsgruppe in Wien durchgeführt.

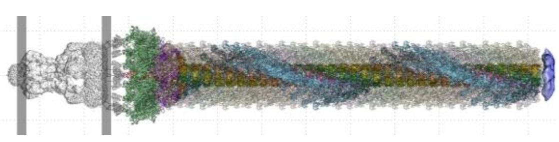
Im Rahmen des Forschungsprojektes werden

a) Proteine (rekombinant) und Peptide (synthetisch) hergestellt und charakterisiert
b) Funktionalisierte Moleküle für die Derivatisierung der Proteine und Peptide synthetisiert und charakterisiert (NMR, MS, etc.)
c) Proteine und Peptide mit den dargestellten funktionalisierten Molekülen derivatisiert

d) Die erhaltenen Konstrukte mit verschiedenen Methoden (z.B. präparative HPLC) gereinigt und mit verschiedenen analytischen Methoden charakterisiert UPLC-MS). Welche Teilaspekte im Rahmen des Kurses behandelt werden hängt von den aktuellen Fragestellungen im Forschungsprojekt ab.

34. Analysis of dynamics of the bacterial Type six secretion system by advanced live-cell imaging techniques
Marek Basler

1 course with 2 students

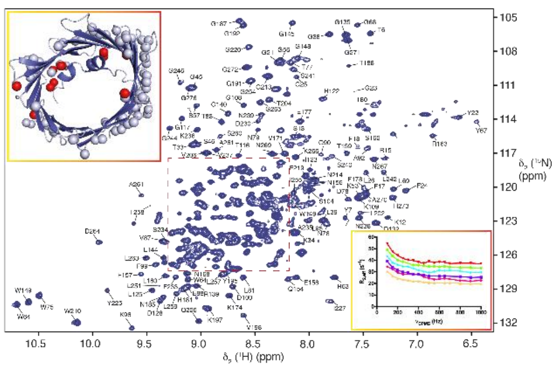


Bacteria live in a constant fight over space and resources with other organisms. To survive they evolved several mechanisms to kill their competition. One such system is the Type 6 Secretion System (T6SS) that is in about 25% of all Gram-negative bacteria and can deliver proteins into both bacterial and eukaryotic cells and is thus important for bacterial competition but also for pathogenesis of several human pathogens.

In this project, you will be involved in our attempts to describe dynamics of T6SS components in various organisms. You will use advanced imaging techniques such as structured illumination microscopy, single molecule localization microscopy or fluorescence-lifetime imaging. You will also learn basics of working in a microbiology lab such as cultivation and manipulation of various bacterial strains.

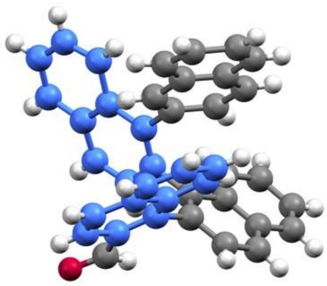
You research will help to answer what are the common and unique steps in localization of T6SS components in different bacterial species. How cells sense external cues and how this is converted into localized assembly of protein complexes. What are the advantages and potentially also disadvantages of localized T6SS assembly during bacterial interactions and infection.

35. Protein interaction and dynamics by solution NMR spectroscopy
Sebastian Hiller
1 course with 2 students



The functionality of any protein requires specific movements of individual structural segments as well as interactions with other biomolecules. Solution NMR spectroscopy can quantify these features at atomic resolution even for large proteins to provide insights into functional mechanisms. In this block course, the students learn key aspects of modern high-resolution NMR spectroscopy with proteins in aqueous solution. We will quantify molecular interactions and dynamics of a protein under physiological conditions and correlate these measurements with the protein function. We will produce the protein in suitable isotope-labelled form, measure chemical shift perturbations and nuclear spin relaxation parameters and quantify the underlying interactions and molecular motions. An atomic resolution description of the protein function will emerge.

37. Synthese molekularer Gerüsteinheiten
Ch. Sparr
Pro Kurs 1 Student



Wohldefinierte molekulare Gerüsteinheiten sind nicht nur in der lebenden Natur Voraussetzung für Gestalt und Funktionalität, sondern bieten auch eine Grundlage für neuartige nanoskalige Architekturen. Dabei spielen stereogene Strukturelemente eine besonders wichtige Rolle. Um Zugang zu verschiedener molekularer Topologien zu erhalten, entwickelt unserer Gruppe selektive Synthesemethoden um diese Strukturelemente mittels moderner Katalyse herzustellen.

Der Kurs bietet Einblick in folgende Themen:

1. Substrat- und Bausteinsynthese
2. Enantioselektive Synthese axial-chiraler Verbindungen
3. Charakterisierung der Produkte durch NMR, IR, MS und HPLC
4. Diastereoselektive Herstellung von Oligomeren (Bild)
5. Charakterisierung durch Röntgenstrukturanalyse
6. Anwendungen in der Nanochemie

Die Teilnehmer werden diese Themen anhand eines aktuellen Forschungsprojekts bearbeiten

39. Biophysics of bacterial biofilm communities
Knut Drescher

Pro Kurs 1 Person

Most bacteria on Earth live inside surface-attached communities called “biofilms”. These biofilms can initiate from a single cell and grow up to several millimeters or even centimeters in size. Bacteria inside such biofilms are intrinsically tolerant to antibiotics and other toxins. Therefore, biofilms in medical settings are very difficult to eradicate, and cause numerous acute and chronic infections. This experimental blockcourse will focus on characterizing biophysical processes in biofilms formed by pathogenic bacteria. The particular topic will change each year, but the topic will be broadly within the range of topics mentioned below: Characterization of transport of molecules (e.g. antibiotics) into and out of biofilms, interactions between biofilms or between different sub-populations inside biofilms, development of microfluidic methods for biofilm cultivation, or the development of robotic techniques for biofilm manipulation. This blockcourse will train the students in basic microbiological techniques for working with pathogenic bacteria, basic genetics, microfluidics, confocal fluorescence microscopy, and additional techniques for investigating biofilms as needed (e.g. software control for robots).

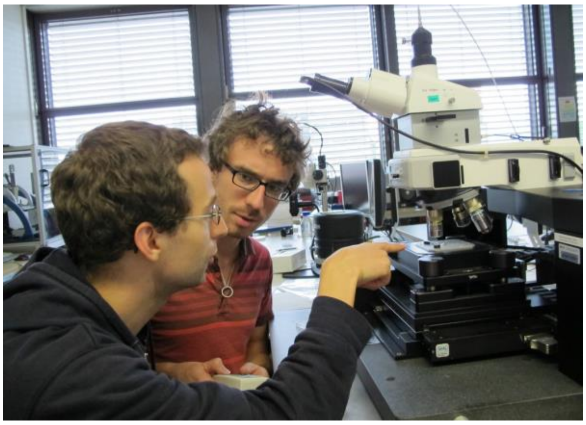
B. 1 Woche ganztägig, in der vorlesungsfreien Zeit, 3 KP pro Kurs

Für die Kurse müssen Sie neben der einen Woche Kurs zusätzlich Zeit für die Vorbereitung und für den Bericht einplanen.

FHNW Muttenz

18. Surface modification and nanosensors
J. Köser FHNW (1 week intensive course)
Pro Kurs Max. 8 Studierende, Min. 4

The one-week practical training intensive course focuses mainly on biosensing technologies. This includes preparation of the active sensors and study of biomolecule interactions The course is composed of the following tasks which have to be addressed during this one week practical training:
1) Surface cleaning and activation
2) Chemical functionalisation of surfaces
3) Chemical structuring of surfaces utilizing micro contact printing
4) Immobilisation techniques to couple biomolecules to functional surfaces
5) Applications in biosensing: quartz crystal microbalance, cantilever based stiffness sensor, protein assay, lateral flow assay



The one week course will introduce the students to most recent methods for surface functionalization of common sensing platform materials e.g. glass, silicon, gold on glass, gold on polymers and polymers itself. The students will learn about the very critical issue of surface cleaning and the effect on surface functionalisation and they will determine residual components on the surface using spectroscopic and microscopic technologies. For surface functionalisation the students will perform silanization reactions, “self assembled monolayers based on thiol chemistry, layer by layer coating and plasma functionalisation. In particular the plasma technology offers a broad variety of possibilities from simple surface cleaning and activation, to depositing complex, functional layers.The generated layers or functional surfaces will be characterized by various methods e.g. contact angle measurement, determination of surface energy, analysis of the chemical compositions with X-ray spectroscopy or grazing angle infrared spectroscopy. Furthermore microscopic methods like SEM, Confocal microscopy and others will be used to measure the topography and surface roughness. In the context of surface modifications the influence of surface chemistries, topography resp. material properties on the specificity and activity of immobilized or interacting biomolecules will be critically discussed. This is of particular importance for biocompatible materials e.g. implants, artificial bone etc., because of the acceptance by living tissue and the risk of inflammation. In the area of biosensing surface effects can influence the specificity and functionality of the immobilized biomolecules. This could lead to wrong or deviating results depending on the sensing systems used. This has to be considered comparing results from different sensing technologies. In addition to surface functionalization, methods to chemical structure a surface will be trained during the course in theory and practice. As example therefore micro contact printing experiments will be performed. With the casted stamps patterns of fluorescently labelled biomolecules will be transferred to an activated surface and the results will be analyzed by fluorescent scanning of the structured surfaces or fluorescence microscopy. The students will get a broad introduction into the theory and practical application of modern sensing technologies. In practical exercises they will make use of the functionalized surfaces and apply them to perform experiments in the area of DNA/RNA micro arrays, quartz crystal microbalance sensing, cantilever based stiffness sensors, protein assays and lateral flow assay. Cantilever based sensing SPR and acoustic wave sensing, to couple biomolecules to the surfaces in a structured manner, to measure the results of the biomolecule.

19. Functional biocompatible materials for medical applications

J. Köser, M.de Wild

FHNW (1 week intensive course)

Pro Kurs Max. 8 Studierende, Min. 4

The one week practical training intensive course focuses mainly on biocompatible materials used in medical applications. This includes preparation and analyzing of the specimen and furthermore the chemical and morphological modification of their surfaces. The following topics will be covered:

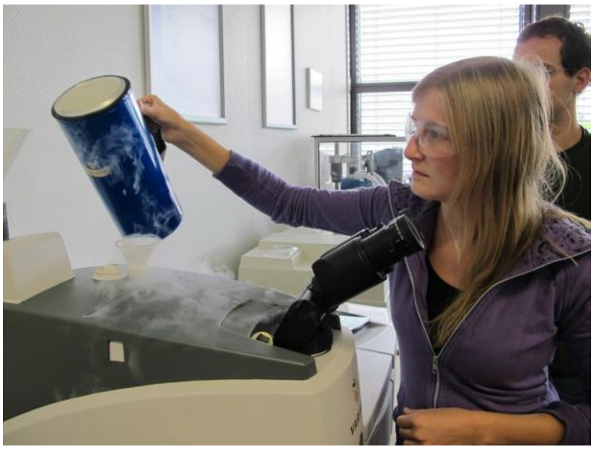
- Morphological modification of material surfaces (e.g. sandblasting, shot-peening, electropolishing and etching)

-Preparation techniques: cutting, embedding, grinding, polishing, and etching (e.g. metals, ceramics, polymers, porous materials, foams)

- Methods for the characterization of biocompatible materials (e.g. morphological, chemical and mechanical) and biocompatibility/cytotoxicity tests

- Chemical functionalization of materials e.g. Al, Si, Ti, Au, Glass, Polymers etc. by various methods.

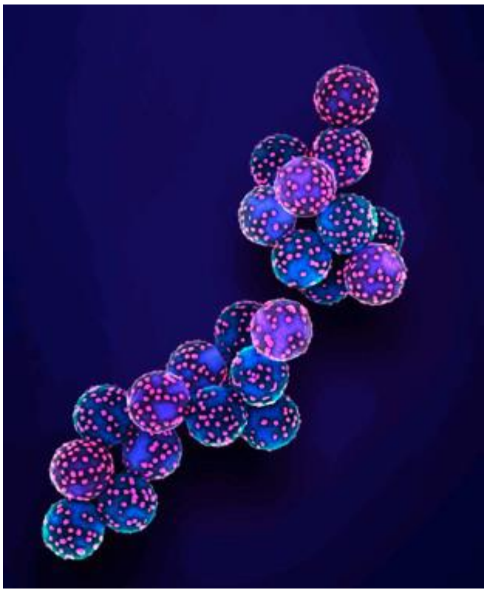
It is of outermost importance and prerequisite to know the bulk microstructure, the microstructural constituents, the static and dynamic mechanical properties and the surface morphology and chemical composition of biocompatible materials when using it in a medical device or other medical applications. This knowledge is requested by the authorities to guarantee the materials quality and avoidance of unwanted side effects when the materials come into contact with human tissue or body fluids. During the one week practical training course the students will be introduced to most recent methods for biomaterial modification and characterization.



The students will learn how to prepare the different materials e.g. titanium or ceramics

for the morphological, mechanical and chemical composition analysis. The students will be trained to embed, cut and polish the specimens in order to investigate e.g. texture, grain size, layer thickness and roughness. To investigate topographical features the students will be introduced to advanced microscopic technologies like SEM, confocal microscopy, polarising microscopy and others. The chemical composition will be determined by spectroscopic methods e.g. ToF-SIMS, EDX, IR or Raman Imaging. Furthermore static and dynamic mechanical properties will be determined by tensile measurements as well as fatigue testing on a e.g. servo-hydraulic system.Critical issues like surface energies measured by tensiometry and contact angle will be addressed and their importance discussed in the view of the medical application of the material
e.g. wetting of titanium with body fluids. In addition to the sample preparation and material characterisation, the students will learn in various practical exercises how to chemically activate, coat, functionalize, passivate or mechanically/chemically structure the materials surfaces and study the impact on the materials characteristics and their behaviour in biological environments (Body fluids e.g. blood or cell cultures).
In the frame of the course the students will follow the entire industrial development chain of biocompatible materials used in medical applications.
Goals of the course:
-The students are familiar with the most common methods to prepare specimen e.g. implants for materials investigations
-The students are familiar with modern methods for materials characterization with respect to both, the chemical composition and mechanical properties of the bulk material and the surface
-The students will have an overview of the most state of the art methods to chemically and physically modify surfaces of biocompatible materials.
-The students will gain insight in the analytical methods allowing the biocompatibility assessment of biomaterials.
-The students are aware about the importance of the interface of materials and the biological environment for their proper function in the medical applications.

31. Engineered functional nanoparticles
Patrick Shahgaldian FHNW
Pro Kurs max. 4 students



Engineered functional nanoparticles find applications in an exponentially increasing number of industrial sectors. As the surface physico-chemical characteristics of nanoparticles mostly dictate their general behavior and performance, the development of methods to chemical or physically modify the surface of nanoparticles is a foremost research focus in nanotechnology. In this Blockcourse, you will have a first hands-on experience on how to handle and chemically modify the surface of inorganic oxide nanoparticles for two distinct applications:

1) Chemical nanostructuration of the surface of silica nanoparticles, to yield nanomaterials with protein recognition properties

2) Functionalization of silica nanoparticles to produce efficient enzyme-based nanobiocatalysts

This blockurse, along with theoretical highlights, will involve a body of synthetic and analytical work. The produced nanoparticles will be analyzed using state-of-the- art electron microscopy methods, scanning probe microscopy and photon correlation spectroscopy. The functional properties of the produced nanosystems will also be assessed using spectrophotometric and/or immunological methods.

Paul Scherrer Institut (PSI)

16. Doppelblockkurs : Oberflächenphysik im NanojunctionLab am Paul Scherrer Institut

M. Heinrich, A. Ahsan, Ch. Waeckerlin, T.A. Jung
Max. 6 Studierende pro Semester

Am PSI sind Doppelblockkurse unter Einbezug des Synchrotrons möglich. (UV und Röntgen Photoelektronenspektroskopie, Röntgenabsorptionsspektroskopie (engl. UPS, XPS, XAS) an der "Swiss Light Source" zusammen mit Rastertunnelmikroskopie (engl. STM) oder Rasterkraftmikroskopie (engl. SFM) im Labor. Diese Projekte müssen individuell abgesprochen werden.

Voraussetzungen: Interesse für Oberflächenphysik und für disziplinenübergreifende Forschung (Physik, Chemie, numerische Simulationen) Veranstaltungsort: Paul Scherrer Institut, Villigen PSI, https://www.psi.ch/en/lxn/molecular-nanoscience

Projektbeschreibung:
Anhand eines konkreten Projektes mit Bezug zu aktuellen Forschungsthemen wird selbständig mit oberflächen-physikalischen und oberflächenchemischen Präparationstechniken, Instrumenten und Charakterisierungstechniken gearbeitet.
Einkristalloberflächen werden atomar sauber präpariert, mit Elektronendiffraktion (engl. LEED), und Oberflächenspektroskopie (engl. XPS, UPS) charakterisiert und mit ultradünnen Materialschichten (Molekulare Materialien /Isolatoren) bedeckt. Mit dem Rastertunnelmikroskop oder dem Rasterkraftmikroskop werden die so erzeugten Oberflächen abgebildet und die Daten analysiert und interpretiert. In Kombination dieser Methoden kann die atomare wie auch die elektronische ‚Struktur' und chemische Koordination von Atomen und Molekülen an Oberflächen erarbeitet werden. Für den Bericht soll unter Anleitung und selbständig nach weiterfuehrenden Beitraegen in der aktuellen wissenschaftlichen Literatur gesucht werden, und ein fokussierter Aspekt anhand der verfügbaren Daten interpretiert und diskutiert werden.
Eventuell besteht die Möglichkeit der Teilnahme an Experimenten im Rahmen einer Strahlzeit an der "Swiss Light Source". Dies kann auf Wunsch bilateral vereinbart werden.

Kursbeschreibung:
Doppelblockkurs, 2 Wochen Vollzeit, Unterkunft im PSI Gästehaus oder Hotel.
~2 Studierende pro Block. Zeitfenster nach Absprache, auch während der Semesterferien möglich.
Weitere Informationen / typische Projekte / Stellenausschreibungen:
https://www.psi.ch/en/lxn/molecular-nanoscience#news-and-highlights
Mail: thomas.jung@psi

17. X-ray microscopy at the PSI
Armin Kleibert, Simone Finizio, and Frithjof Nolting
Pro Kurs 5 Studierende
Minimum: 2 Maximum: 5

One group at the PEEM (max 2 students)
One group at the STXM (max 3 students)

Prerequisite: Interest in solid state physics
Location: Swiss Light Source, Paul Scherrer Institut, Villigen PSI, www.psi.ch\sls
Minimum: 2 Maximum: 6 (students will work in groups of maximal 3 students)
Learning the basics of X-ray absorption spectroscopy and microscopy and apply them to the study of magnetism at the nanoscale. Exploring the world of reduced dimensions in solid state physics is a challenging and rewarding research area. When the dimensions reach the nanometer scale, quantum mechanical and thermodynamic properties that are insignificant on macroscopic scales dominate more and more, resulting in new and interesting properties. In order to understand the behavior of magnetic systems in reduced dimensions the knowledge about the details of the magnetic domain structures is important. A powerful tool for this is imaging with X-rays since this combines absorption spectroscopy with high spatial resolution.

Course outline:
- Basic tutorials about X-ray absorption, X-ray magnetic dichroism and X-ray imaging
-Carry out microscopy experiments at the PolLUX beamline (https://www.psi.ch/sls/pollux/pollux) using a scanning transmission X-ray micrscope (STXM)
- Carry out microscopy experiments at the Surfaces/
Interfaces: Microscopy beamline (http://www.psi.ch/sls/sim/sim) where you will operate a state-of-the-art photoemission electron microscope (PEEM)
- Study the magnetic domain structures of systems in reduced dimensions
Literature:J. Stöhr, H.C. Siegmann, Magnetism, (Springer, Berlin, 2006)

22. Neutron scattering in solid state physics: diffraction, spectroscopy and reflectometry
M. Kenzelmann, L. Keller

Location: Paul Scherrer Institute, Villigen PSI, http://www.psi.ch/lns
Prerequisite: Solid State Physics

Min: 2 Students Max: 4

In this 5 day intensive course at the Swiss spallation neutron source SINQ [1] you will learn the basic principles of three different neutron scattering techniques and their applications in solid state physics: neutron diffraction, neutron spectroscopy and neutron reflectometry [2].

- Magnetism is omnipresent in condensed matter physics. In this practical course you will learn how to perform a neutron powder diffraction experiment, apply all the necessary corrections, as well as to analyze the data in order to determine the chemical and the magnetic structure of crystalline materials. In particular you will reproduce the experiment that lead to the Nobel prize awarded to C.G. Shull in 1994.

- You will learn how to conduct an inelastic neutron scattering experiment using a state-of-the-art triple-axis neutron spectrometer. Your task is to measure the phonon dispersion curves of a lead single-crystal, in order to deduce a series of fundamental physical properties for this material.

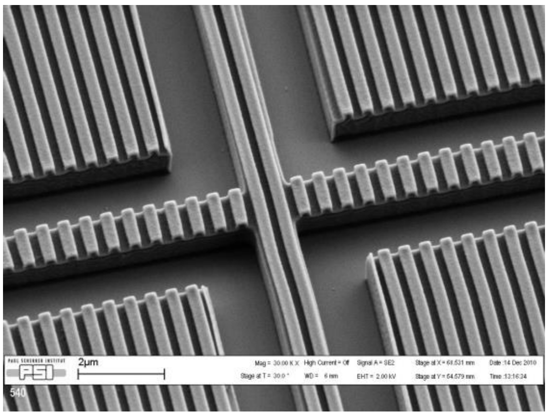
- Neutron reflectometry is a powerful tool to investigate layered materials. You will apply this method to alternating layers of Ni and Ti on a glass substrate and determine the properties of the periodic nature of these mulilayers.

[1] http://www.psi.ch/sinq
[2] G.L. Squires, Introduction to the theory of thermal neutron scattering, Dover Publications (1978)

23. Micro- and nanofabrication of surface topographies

Name Kursverantwortlicher: H. Schift
Ort: Paul Scherrer Institut, 5232 Villigen PSI
Dauer und Art des Kurses: 1 week intensive laboratory course
Maximale Teilnehmerzahl: max. 4 Studierende (mind. 3)

No matter, in which field of nanotechnology (nanoelectronics, medical devices, sensors, scanning-probe instrumentation etc.) the students will specialize later on, it is very likely that they will be confronted with problems of top-down microfabrication since the nanodevices, -structures or -components are very often embedded in a microfabricated environment. This one week intensive laboratory course therefore focusses on top-down micro- and nanofabrication technologies in a state of-the-art clean room environment. The small group of students will be accompanied by an instructor (a process technician or an engineer).
The following topics will be treated during the course:



Introductory lecture on cleanroom operation, and laboratory safety;
Thin film technologies: metal evaporation, surface modification, resist spin-coating;
Pattern definition by photolithography, electron beam lithography, EUV interference lithography;
Pattern transfer: wet and dry etching, resist stripping, lift-off;
Replication techniques of topological and chemical structures: nanoimprint lithography, microcontact printing;
Quality control and characterization: optical and scanning electron microscopy, surface profiling.

In this course the students will get acquainted with the most important processes in micro- and nanofabrication, including new lithographic techniques such as nanoimprint lithography. The students will take home different topological and chemical structures for further characterization.

Goals of this course are:
· Get hands-on experience with the most important microfabrication technologies
· Understand the basics and the mechanisms of microfabrication processes
· Learn how to properly work in a professional clean room environment

Further information:
https://www.psi.ch/lmn/
Dr. H. Schift, Paul Scherrer Institut
Tel.: 056 310 28 39
helmut.schift@psi.ch

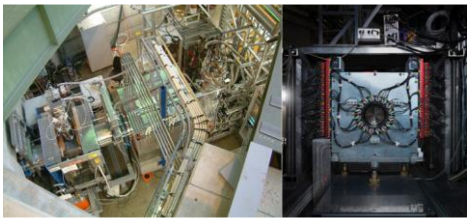
26. µSR spectroscopy of magnetic and superconducting materials

A. Amato, H, Luetkens, T. Prokscha

Prerequisite: Solid State Physics

1 Woche Intensivkurs
Minimum 2, Maximum 4

Location: Paul Scherrer Institut, Villigen PSI, https://www.psi.ch/lmu



Learn the basic principles of muon spin rotation and relaxation techniques (µSR) and use the method to obtain local information about magnetic and superconducting properties of novel superconductors.

This practical course allows learning how a µSR experiment is performed and analysed. It gives detailed insight into a modern local probe technique of condensed matter research making use of a particle beam at a large scale facility such as PSI. In order to do so, you will cool down the sample to a few Kelvin temperatures with a Helium flow cryostat. With the guidance of an instrument scientist, you will run and analyze the experiment using our computerized experimental control and data acquisition system.

The experiment is performed at the General Purpose Spectrometer µSR beam line (GPS, https://www.psi.ch/en/smus/gps) and at the Low Energy Muon beam line (LEM, https://www.psi.ch/en/smus/lem).

Actual research topics of members of the Laboratory of Muon Spin Spectroscopy are chosen for the practicals. These comprise contemporary condensed matter physics questions such as:

- Microscopic study of topical magnetic or superconducting materials. Determination of magnetic phase diagrams, static and dynamic magnetic properties as well the investigation of symmetry and length scales in the vortex state of type-II superconductors.
- Direct measurement of the magnetic field profile on a nm scale and direct determination of the magnetic penetration depth at the surface of a high T_c superconductor (T.J. Jackson, *Phys. Rev. Lett.* **84**, 4958 (2000), R.F. Kiefl, *Phys. Rev.* **B 81**, 180502 (2010)).

Literature:

A. Amato, Lecture Course at U Zurich "Physics with Muons: from Atomic Physics to Condensed Matter Physics", https://www.psi.ch/en/media/63780/download

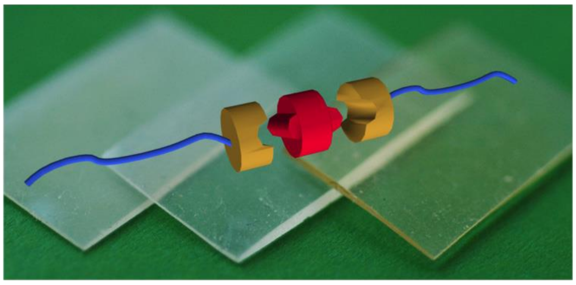
S.J. Blundell, "Spin-Polarized Muons in Condensed Matter Physics", *Contemporary Physics* **40**, 175 (1999)

P. Bakule and E. Morenzoni, "Generation and Application of Slow Polarized Muons", *Contemporary Physics* **45**, 203 (1999)

30. Mechanical testing of functional polymers

C. Weder,
Location: Adolphe Merkle Institute (AMI), University of Fribourg
Max. 2 students, min. 2 students

Commodity plastics are ubiquitous and have revolutionized our lifestyles. As polymer scientists develop the next generation of (nano)materials, they aim to bestow upon them responsiveness, i.e. the ability to respond to a given stimulus in a useful manner. An interesting strategy to achieve this goal consists in utilizing weak interactions (e.g. H-bonding, metal-ligand complexation, ionic interactions or π−π stacking) to form supramolecular assemblies capable of reversibly switching their properties. Such systems can be exploited for instance to make self-healing materials, mechano-morphing systems or mechano-chromic polymers. The block course will explore the mechanical properties of such systems, e.g. as mechanically responsive sensors that exhibit a color change upon deformation, or as materials capable of switching their adhesion properties. The research methodology will include the fabrication and characterization of polymer films within the framework of a polymer materials laboratory, and specifically the use of thermomechanical characterization methodologies to evaluate the response of such materials.



Further information:
Prof. Christoph Weder
http://www.am-institute.ch/research/polymerchemistry-materials
christoph.weder@unifr.ch

EMPA

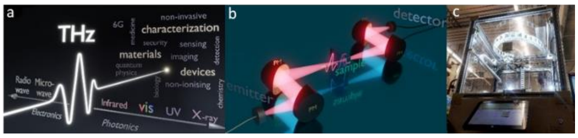
25. Exploring the THz regime

Elena Mavrona, Erwin Hack, Michel Calame

Location: Empa - Materials Science & Technology, Ueberlandstrasse 129, 8600 Dübendorf

Min. 2, max. 2 Students

THz radiation is non-invasive and non-ionizing, and many exciting phenomena in biological (molecular vibrations) to quantum systems (ultrastrong coupling) occur and can be probed at this wavelength. The THz regime is at the border between optics and electronics, and its exploitation emerged only in the last decades. To make THz technology more accessible today, new sensitive and low-cost THz devices need to be developed.

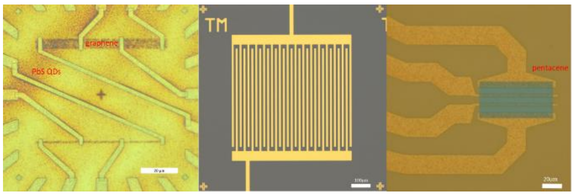


a) The THz regime b) A blender illustration of a THz time-domain spectroscopy c) The 3D printer that will be used for this work.

In this course, the students will learn basic methods for the development of THz devices. They will have the opportunity to fabricate their samples and devices such as THz lenses using microfabrication techniques, spin-coating and 3D printing using THz transparent materials such as cyclic olefin copolymer. The students will also get familiar with THz technology using THz characterization techniques including THz time-domain spectroscopy and imaging to characterize their samples. Moreover, they will characterize the thin films' optical properties and thickness with ellipsometry.

40. Hybrid electronic & optoelectronic devices

Gökhan Kara, Jacopo Oswald, Ivan Shorubalko, Michel Calame
Location: Empa - Materials Science & Technology, Ueberlandstrasse 129, 8600 Dübendorf
Min. 2, max. 4 Students



Hybrid nanoscale interfaces are a perfect platform to explore new concepts in emerging frontiers of electronics and optoelectronics devices for applications in communication, energy, and life science technologies. In particular, the combination of low dimensional materials such as graphene with nanocrystals or molecules gives rise to unprecedented properties both in transport and optical response.

In this course, you will get hands-on experience with opto-electrical measurements in the laboratory of transport at nanoscale interfaces. The goal is to individually study the constituents (graphene, nanocrystals/molecules) in a field-effect architecture and explore what changes if they are combined.

You will have the opportunity to train your practical skills through the following tasks:

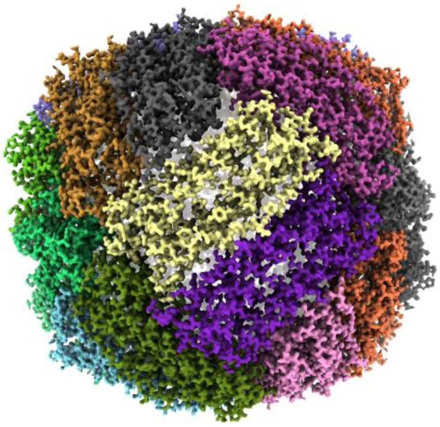
- Introduction to transfer of CVD (chemical vapour deposition) graphene on a substrate followed by Raman spectroscopy.
- Electrical characterization of graphene-based field-effect transistors (FET), as well as nanoparticles and molecules, using interdigitated finger electrodes.
- Optical characterization to determine the photo-responsivity of devices.
- Documentation and data analysis: fitting of the measured data and extraction of parameters.

Further information:
Dr. Ivan Shorubalko, Prof. Dr. Michel Calame
https://www.empa.ch/web/empa/transport-at-nanoscale-interfaces

EPFL

39. Structure determination of protein complexes by cryo-transmission electron microscopy and image processing

Babatunde Ekundayo, Dongchun Ni, Inayatulla Mohamed, Meltem Tatli, Amanda Lewis, Henning Stahlberg
2 Students



The structure of Ferritin with an iron core, here at 1.38Å resolution. This map was obtained with the instruments of the Dubochet Center for Imaging in Lausanne.

This one-week intensive block course will take place in the Laboratory of Biological Electron Microscopy (LBEM) in the Physics institute of the EPFL in Lausanne, Switzerland. In the LBEM, our group is using electron microscopy to understand the structural mechanisms underlying neurodegeneration. We study several membrane protein and soluble protein systems that play a role in diseases such as Parkinson's disease or Alzheimer's disease. For this, we purify in the lab the proteins, study their structure by cryo-electron microscopy (cryo-EM) and image analysis, and interpret these structures in the context of structural studies of human brain tissue from patients suffering from neurodegeneration. For this, the lab has access to the frontier equipment of the Dubochet Center for Imaging, which is a facility in our institute that offers cryo-EM at highest resolution to customers. The LBEM is also developing novel approaches to electron microscopy, using stroboscopic electron illumination or coherent electron diffractive imaging, for which the LBEM operates its own electron microscopes.

In this block-course, the students will participate in the structural analysis of a protein complex. Students will purify proteins, prepare these for electron microscopy investigations as negatively stained preparations or as frozen hydrated thin films, screen samples by themselves on transmission electron microscopes, participate in the high-resolution data collection with the high-end cryo-EM instruments of the Dubochet Center for Imaging in Lausanne (including a 300kV Titan Krios with latest features), and perform computational image analysis for obtaining a 3D reconstruction of the protein structures.