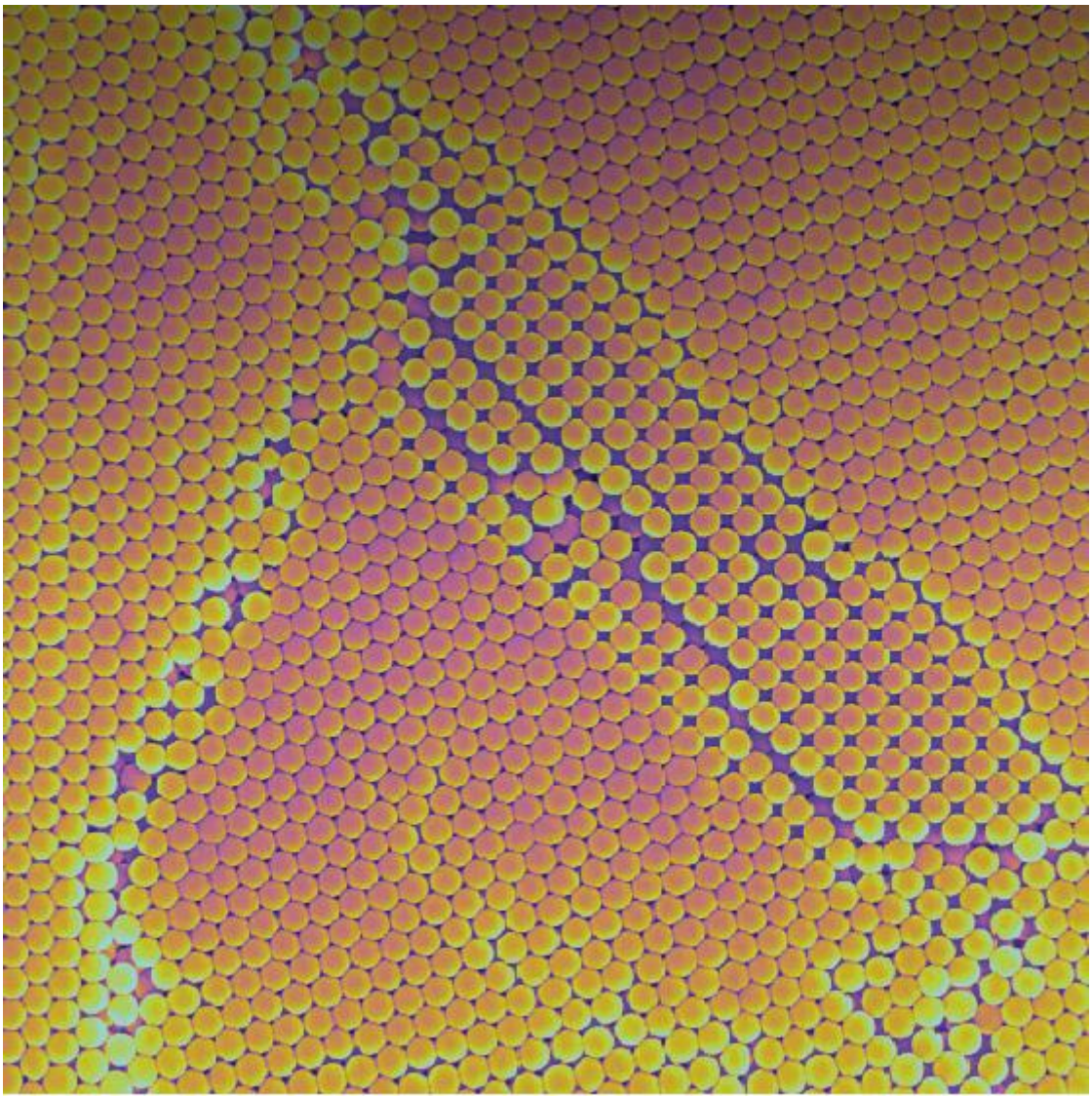
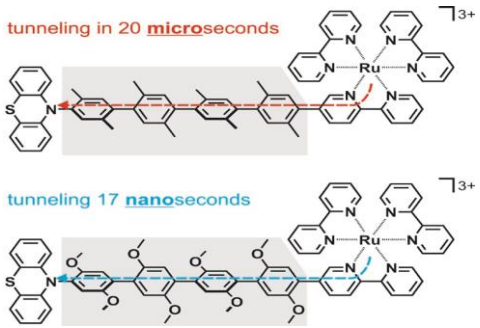
Kursbeschreibung Blockkurse 2024/2025



Mikrokugeln aus Styrol (V. Hollenstein, L. Martinez und S.Saxer (FHNW)

Inhalt

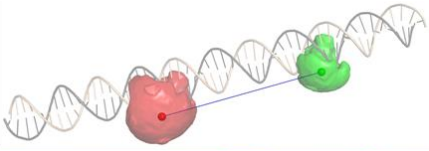
A. Zeitdauer 3 Wochen, nachmittags, 3 KP pro Kurs

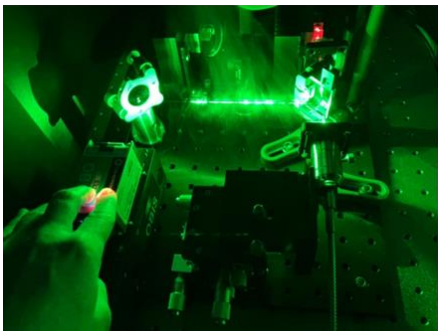


1. Single-molecule Förster Resonance Energy Transfer (smFRET) as a spectroscopic nano-ruler

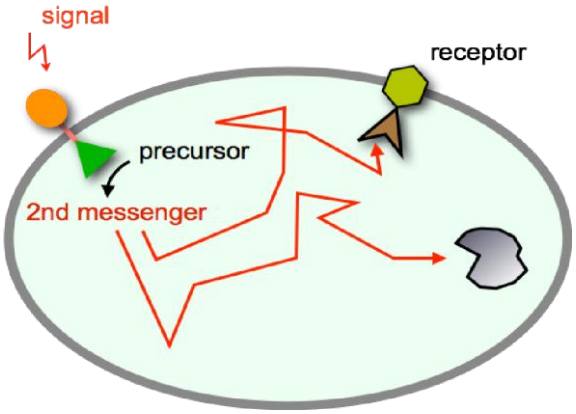
S. Schmid

Pro Kurs 2 Studirende





Single-molecule experiments can overcome the ensemble and time-averaging effects of conventional bulk experiments. We use Total Internal Reflection Fluorescence (TIRF) microscopy to detect hundreds of single fluorescent molecules in parallel. Förster Resonance Energy Transfer can be used as a nanoscopic ruler with high spatial (nm) and temporal (ns – ms) resolution to characterise conformational changes within single (bio-)molecules. In this block course, you will observe the conformational changes of single DNA Holliday junctions in real-time and measure nanoscopic distances by smFRET. You will prepare the

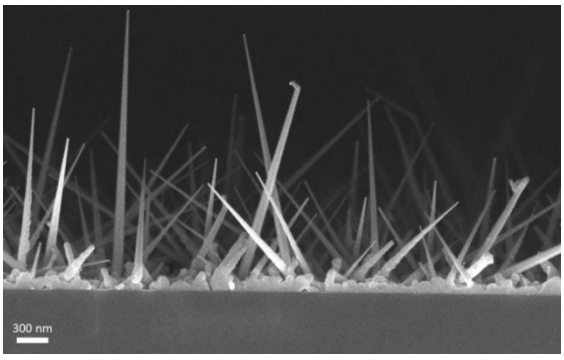


biomolecular samples, measure smFRET at our state-of-the-art open-beam laser setup, and analyse your data to extract the relevant time-resolved trajectories. The learning goals of this course are: (i) knowledge of the additional information offered by single-molecule experiments compared to ensemble experiments; (ii) the physical basis of smFRET, the corrections for experimental crosstalk, and nanoscale distance derivation; (iii) kinetic rate extraction from watching conformational changes in real-time; (iv) understanding the thermodynamics vs. kinetics of these dynamic molecular systems.

2.1 Synthesis of nanostructured materials

Ilaria Zardo

Pro Kurs 2-3 Studirende

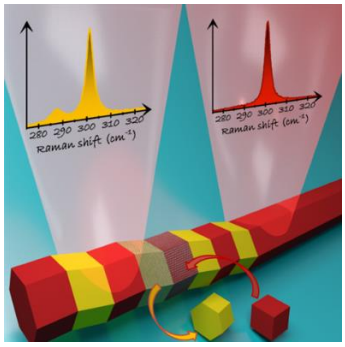


Nanostructures have been extensively investigated in the last two decades as

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.

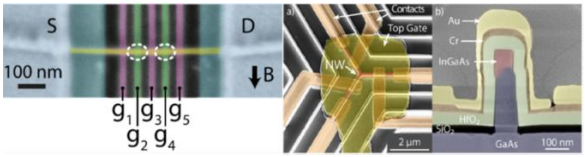
2.2 Spectroscopy of Phonons
Ilaria Zardo

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



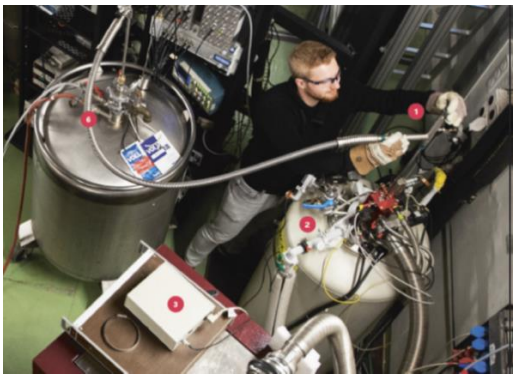
3.1 Semiconductor Nanofabrication Course
(groups of min. 2, max. 3 persons)

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 the unique resources of quantum mechanics, such as superposition and 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

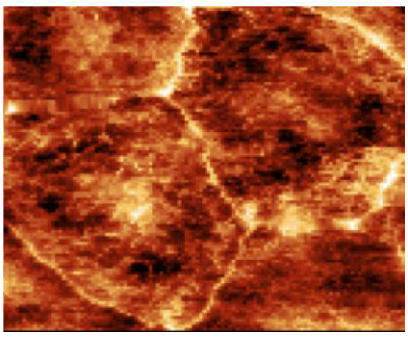
3.2 Quantum transport experiments
Cryo-Lab Measurement Course
(groups of min. 2, max. 3 persons)



Recommended prerequisite for this course: Condensed matter physics. Ideally (but not mandatory), the Semicond. Nanofabrication Course is taken before the cryolab course.

Quantum transport is the study of quantum phenomena probed with electrical means, typically using nanoscale devices at low, cryogenic temperatures. Conductance quantization in 1D constrictions and the discrete energy levels of a tiny, isolated island forming a 0D system – a quantum dot – are some of the most striking phenomena in quantum transport experiments and are providing a basis for a quantum unit of information – a qubit. The spin of an electron (or hole) is of particular interest as a qubit. It forms a natural two-level system, well enough isolated from the environment to enjoy excellent coherence, yet it can be manipulated relatively fast and easily.
In this course, you will study one of these phenomena in our cryo lab. With the guidance of a teaching assistant, you will cool down a device to low temperatures in a cryostat or dilution refrigerator. You will use low-noise electrical techniques and superconducting magnets to investigate the quantum physics. We will provide the samples. (In the Nanofabrication course, you can learn fabricating 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. Cell-material interactions and Tissue Engineering
G. Guex
Cell-material interactions and Tissue Engineering, Oral Implantology, UZB
For 1 to max. 2 persons

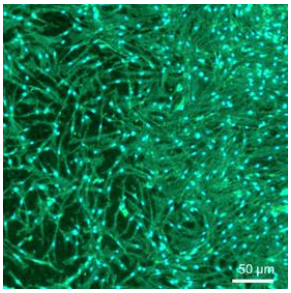
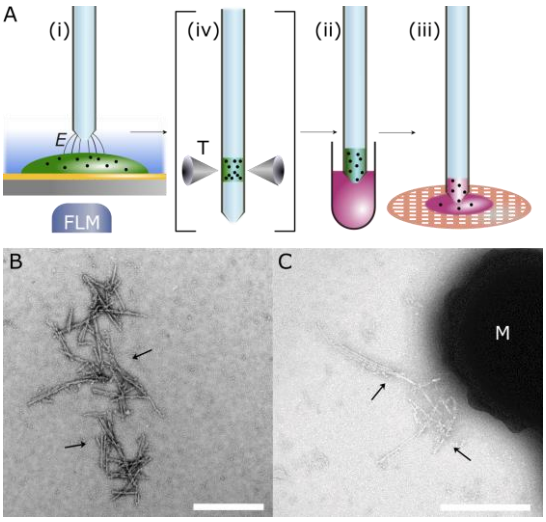


Figure 1: Fluorescence microscopy image of human gingival fibroblasts (HGF-1) cultured on a titanium-based substrate. Cells are stained with Phalloidin to label the actin skeleton (green) and with DAPI to stain nuclei (blue)

A thorough understanding of cell material interactions is paramount to design new implants or improve existing ones with functional coatings. This holds true in a plethora of applications and clinical situations, ranging from biografts to restore diseased or lost soft tissue to metal or ceramic-based implants in orthopaedics or oral implantology. By tuning the mechanical, physical, chemical or biological properties, implant surfaces can be designed to control cell fate and differentiation, soft-tissue adhesion, osseointegration or immune reactions. In this block course, you will learn the fundamental principles in tissue engineering, regenerative medicine and oral implantology. You will gain hands-on experience in material characterisation, cell culture, different analytical methods and fluorescence microscopy.

7. Single Cell Visual Proteomics to Study Neurodegenerative diseases

T. Braun
2 Studierende



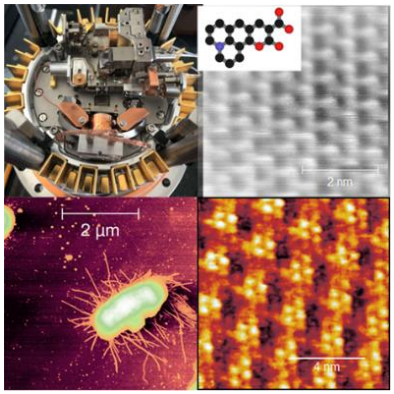
Stereotypic spatiotemporal spreading of pathological lesions through the nervous system is a hallmark of many neurodegenerative diseases. The prion-like spreading model provides an elegant explanation for this observation, postulating that misfolded proteins (amyloids) can disease healthy cells by imprinting their misfold onto endogenous proteins. However, the precise spreading mechanism is still unknown.

Electron microscopy (EM) is an underrated analytical tool geared to analyze minimal amounts of samples. Optimally, EM is combined with microfluidic, lossless sample preparation methods. In recent years, we developed a modular microfluidic system for single-cell analysis by "visual proteomics." We will develop these methods further to study the prion-like spreading mechanism involved in neurodegeneration.

In the block course, we will first develop amendments to the cryowriter system to improve single-cell sample preparation. This involves hardware and software developments. Subsequently, we will apply the redisigned instrument to study single cells by visual proteomics (EM).

9. Scanning Probe Microscopy

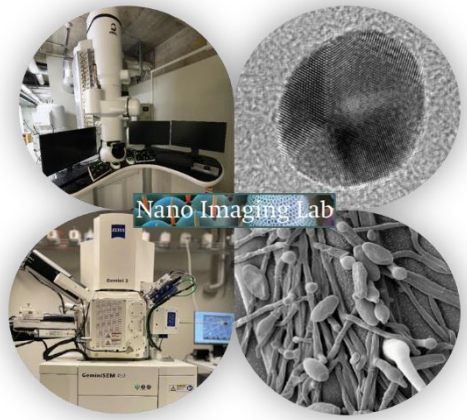
E. Meyer/T. Glatzel
Pro Kurs 4 Studierende



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. Nanoscopic imaging and analysis
M. Wyss
Pro Kurs 9 Studierende



In this course, we would like to teach you the techniques of imaging in the micro- and nanoworld. You will receive basic training in scanning electron microscopy (SEM). The focus of this course is on the independent operation of our equipment. You will operate a scanning electron microscope independently, learn several basic preparation methods and carry out energy dispersive X-ray microanalyses (EDX) on specimens. You will demonstrate your acquired skills in a final practical examination and a written report, which will be graded.
You will also gain insights into transmission electron microscopy (TEM), scanning transmission electron microscopy (STEM), selected area electron diffraction (SAED), electron backscatter diffraction (EBSD), focussed ion beam technology (FIB) and confocal laser scanning microscopy (CLSM) through half-day demos.

https://nanoscience.unibas.ch/de/services/nano-imaging-lab/

11. Nanostructuring / Coating by Plasma
Laurent Marot / Ernst Meyer
Pro Kurs 2 or 3 Students

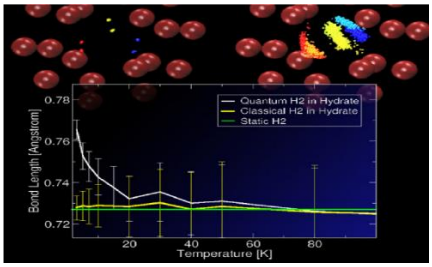
Coating and nanostructuring is way to modify surfaces to achieve new properties. In the course, you will learn how to deposit a thin film of a substrate using the magnetron sputtering technique. The film will be characterized without breaking the vacuum by X-ray photoelectron spectroscopy (XPS) to analyze the chemical composition. Depending on the properties to be achieved (antibacterial….), plasma treatment will follow to nanostructure the surface. Imaging of the surface will be performed by scanning electron microscopy (SEM). You will learn about these techniques and also to be used to vacuum equipment. Thin film growth, interaction of ions and surfaces, and plasma characterization will be the focus of the course. Depending on the topic, new surfaces/materials of are interest for fusion reactor (left image), antibacterial surfaces for implants (left image), or new thin film properties.

https://nanolino.physik.unibas.ch/en/research-1/topics/plasma-surface-interaction-for-fusion-application/

12. Atomistische Simulationen

M. Meuwly

Pro Kurs 2 Studierende

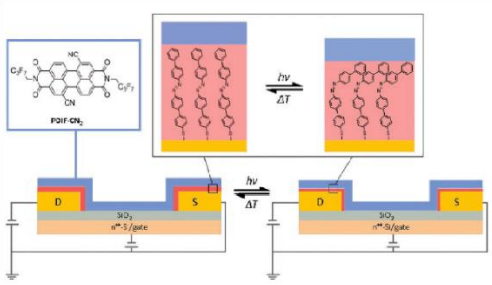


Dieser Blockkurs gibt Einblick in die Durchführung und Analyse von Molekular-Dynamik Simulationen mit spezifischen Anwendungen auf Fragestellungen der kondensierten Materie. Mögliche Themen beinhalten die Untersuchung von Proton-Transfer Reaktionen, das dynamische Verhalten von Wassermolekülen in räumlich 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

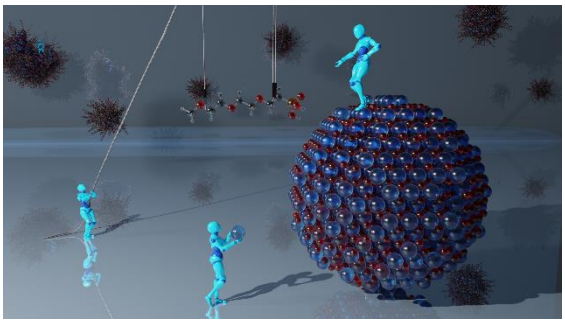


Schematic representation of the device structure showing the reversible isomerization reaction (trans–cis) that takes place at the interface between the semiconductor and AZO-functionalized electrodes.

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

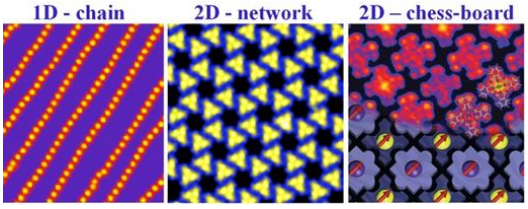
Pro Kurs 1 Studierende



Colloidal nanocrystals and atomically precise nanoclusters are excellent building blocks for nanotechnology. In our lab, we predominantly focus on their application as medical contrast agents and as catalysts for chemical reactions. In this course you can learn about the various aspects of these fascinating materials. You will learn how to synthesize, purify and analyze oxo clusters or oxide nanocrystals. The focus can be either on the inorganic chemistry, the synthesis of nanocrystals and clusters, or their surface functionalization. Investigations of the reaction mechanism help us to develop better materials, while analyzing the structure using X-ray scattering techniques and NMR spectroscopy grants insights in structure-property relations.

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`)

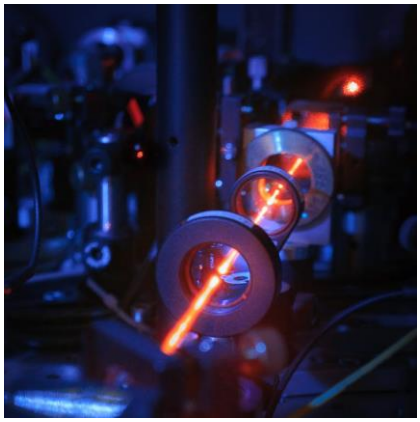


Anhand eines aktuellen Forschungsprojektes wird selbständig mit Oberflächenphysikalischen und Oberflächen chemischen Präparationstechniken, Instrumenten und Charakterisierungstechniken gearbeitet. Die Blockkursteilnehmer werden ins die Forschungsarbeit des Teams integriert. Mehr - heitlich haben Projekte Bezug zur Grundlagenforschung, aber auch anwendungsnahe Projekte in Zusammenarbeit mit Firmen (Roche, Glas Trösch, Ferrovac und ABB) stehen für Interessierte zur Verfügung. Zwei Fragestellungen stehen im Vordergrund:
1.) Die Erzeugung von Polymerarchitekturen durch eine Kombination von Supramolekularer Chemie, Koordinationschemie 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

17. Low temperature quantum transport – Quantum Hall Effect
Andrea Hofmann
Pro Kurs min. 2 max. 3 students

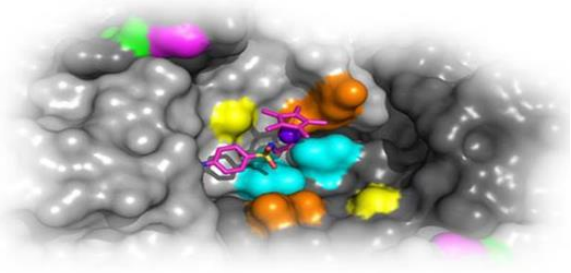
Our everyday live takes place in three dimensions, at about room temperature, and in the small earth magnetic field. If we confine electrons into two dimensions, cool them down to low temperatures and apply magnetic fields, their flow (the current) exhibits interesting quantum features. The current flows in edge channels along the boundaries and situations arise where the conductivity and the resistivity simultaneously are zero. In this course, you will join us in cooling down semiconducting samples to temperatures near absolute zero and to investigate the emerging quantum behavior in electron transport.

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.

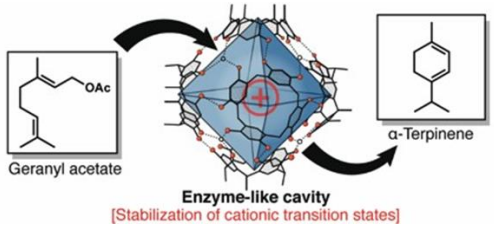
21. Engineering protein-hosts for transition metal catalysts
Thomas R. Ward
Pro Kurs 1 Studierende



Die Derivatisierung von Übergangsmetall-komplexen mit Gruppen, die mit hoher Affinität an Gastproteine binden, ermöglicht die spezifische Lokalisierung

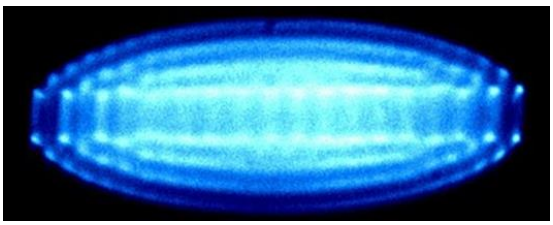
katalytischer Komplexe in Proteingerüsten. Durch Mutation der Proteinhüllen kann die Funktionalität der Metallkomplexe massgeblich beeinflusst werden. Der Kurs bietet die Möglichkeit eines Einblicks in:
1) molekularbiologische Arbeitsweisen
2) die Synthese von Übergangsmetall-komplexen und relevanten 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:
-Synthese von Bausteinen für den Aufbau von Nanoreaktionskammern bzw. -
Synthese von Substraten für katalytische Umsetzungen in Nanoreaktionskammern.
Zusätzliche Informationen zu dem Thema sind auf der Homepage der Arbeitsgruppe Tiefenbacher zu finden:
https://nanocat.chemie.unibas.ch/en/

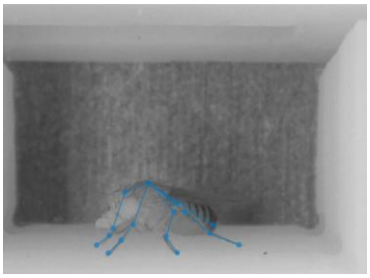
27. Ultracold Ions
Stefan Willitsch
1 course with 2 students



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.

29. Exploring how the fly brain dynamically controls sleep/wake states
Anissa Kempf
1 student pro course

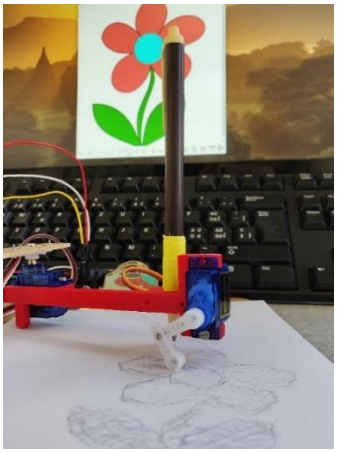


Sleep is essential, yet its function remains one of biology's biggest mysteries. A short or poor night of sleep is usually followed by longer and/or deeper periods of sleep. The existence of such a compensatory mechanism suggests that our brain can monitor the amount of waking time and trigger corrective action if needed. Uncovering the neuronal processes that keep track of the time we spend awake may be key to understanding the function of sleep, and to develop novel targets for the diagnosis and treatment of sleep disorders.

This experimental blockcourse will focus on elucidating how the build-up of sleep need is reflected in changes that ultimately promote sleep, and how sleep is regulated at the level of neuronal networks. We will use the fruit fly *Drosophila melanogaster* as model organism. While the specific projects will change each year depending on where we stand, it will be broadly within the following range of topics: clusterization of sleep/wake states in the fly using high-resolution imaging techniques combined with probabilistic machine learning methods, development of behavioral state-specific closed-loop stimulation methods, development of robotic techniques for sleep/wake state manipulation, development of genetically encoded sensors for the imaging of specific metabolites, recording of neuronal activity in behaving flies using two-photon calcium and voltage imaging, analyzing multidimensional imaging data. This block course will train the students in basic and more advanced neuroscience techniques for recording neuronal activity using two-photon microscopy, performing behavioral experiments, monitoring and manipulating sleep/wake states, basic genetics, and additional methods and analysis techniques as needed.

32. Measurement Control and Acquisition
Martino Poggio

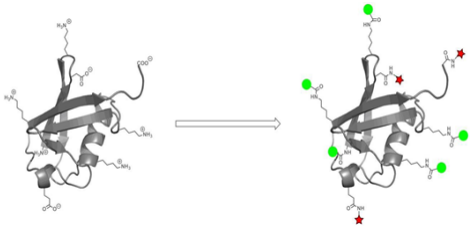
Pro Kurs min . 2 and max. 4 students



The purpose of this course is to teach students the practical aspects of how to run a measurement in the lab, control devices

and do data acquisition. 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 is 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 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.

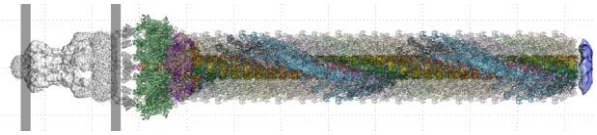
Im Rahmen des Forschungs-projektes werden

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 Forschungs-projekt 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.

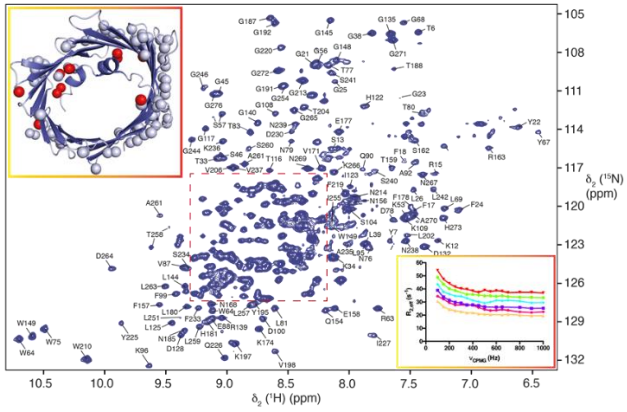
In this project, you will be involved in our attempts to describe dynamics of T6SS components in various organisms. You will use advanced imaging techniques such as structured illumination microscopy, single molecule localization microscopy or fluorescence-lifetime imaging. You will also learn basics 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. Integrative Structural Biology with NMR spectroscopy

Sebastian Hiller

1 course with 2 students



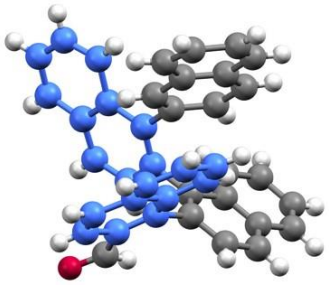
The functionality of proteins requires not only their three-dimensional structure but also specific movements of individual structural segments and interactions with other biomolecules. Solution NMR spectroscopy integrated with cryo-electron microscopy and computational modelling can quantify these features at atomic resolution even for large protein systems to provide insights into functional mechanisms.

In this block course, the students learn key aspects of modern integrated structural biology. We combine high-resolution NMR spectroscopy, cryo-electron microscopy and computational modelling to quantify molecular interactions and dynamics of proteins under physiological conditions and to correlate these measurements with the protein function. We will produce the protein in suitable isotope-labelled form, measure NMR chemical shift perturbations and spin relaxation parameters and quantify the underlying interactions and molecular motions. Combined with cryo-EM data and modelling, an atomic resolution description of the protein function emerges.

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

38. Biophysics of bacterial biofilm communities

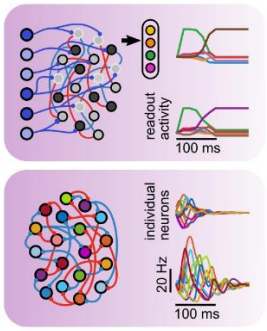
Knut Drescher

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).

41. Theory of neural networks

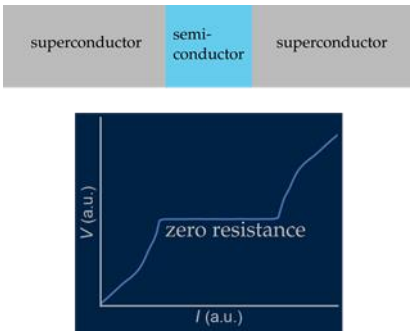
Everton J Agnes/Flavio Donato
1 Person per course



Neural networks are in the spotlight due to a rapid growth in use (and influence) of artificial intelligence and machine learning in our daily lives. Our brains also process information from external or internal signals (the inputs) with intricate networks of neurons that give rise to complex behaviours (the output). Understanding how these neuronal networks work requires theoretical frameworks that unveil the mechanisms by which such inputs can be translated into outputs. In this project, you will learn how to build such networks, studying their dynamics through simulations and mathematical analyses. Associative memory and non-normal amplification are examples of the behaviour of two distinct types of neuronal network models. In the former, an input with incomplete information about a memory pattern is fed into the network which recovers the full memory. This type of behaviour is well explained by networks of interconnected binary neurons which can be analysed with tools from statistical physics. In the latter, specific input patterns are transiently amplified, giving rise to rich and complex dynamics that can be used to, e.g., draw numbers. This type of behaviour is well explained by networks of interconnected linear neurons which can be analysed with tools from linear algebra.

43. Supercurrent measurements

Andrea Hofmann
Pro Kurs min. 2 max. 3 students



Transistors can switch or amplify electric signals and thus are the basic building blocks of today's technology. They are made out of semiconductors. Superconductors build another important class of materials: they carry current without resistance. If we combine superconductors with semiconductors, we can build a switch, where no current flows in the "off" state and a supercurrent flows in the "on" state. In this project, you will be working with these kind of devices. The exact work you will carry out depends on the state of the research project in our group: you will help to answer a current research question.
Prerequisite: Condensed matter lecture required, Nanolithography course recommended

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

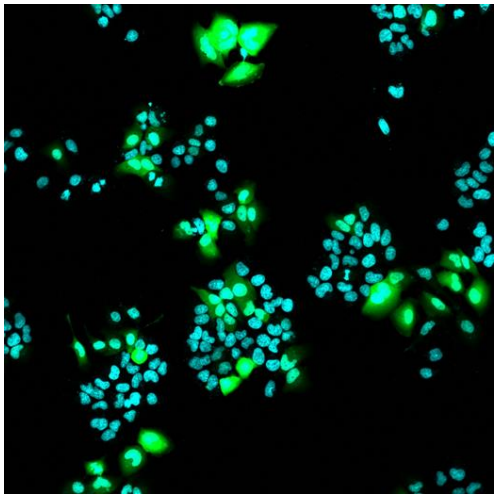
Für die Intensivkurse müssen Sie neben der einen Woche Kurs zusätzlich Zeit für die Vorbereitung und für den Bericht einplanen.

Department of Pharmaceutical Sciences, Pharmaceutical Technology, Unibas

28. Optimization of lipid nanoparticles for gene delivery

J. Huwyler

Pro Kurs max. 2 Studierende, min. 1



DNA lipid nanoparticles (LNPs) are a promising gene delivery system that uses a combination of DNA and lipids to create small, stable particles capable of efficiently delivering genetic material into cells. LNPs are typically composed of a cationic lipid, which binds to the negatively charged DNA, and a neutral lipid, which helps stabilize the nanoparticle structure. The resulting LNPs are able to protect the DNA from degradation and facilitate its uptake into cells, where it can be transcribed and translated into proteins. LNPs have shown potential as a gene therapy tool for a variety of diseases, including cancer, genetic disorders, and viral infections.

The one-week practical training intensive course primarily centers on the preparation of lipid nanoparticles and the transfection of carcinogenic liver cell type HepG2 with genetic material. The production and optimization of lipid nanoparticles will be tested in a screening experiment with HepG2. The curriculum for this internship, which spans a week, includes a series of tasks that will be completed within the given time frame of one week:

1) Manufacturing of Lipid Nanoparticles
2) Testing the different composition of lipids
3) Cellular uptake and transfection efficcency by *in vitro* testing of carcinogenic liver cells
4) Cell viability measurements with MTS method
5) Data evaluation and discussion of optimization strategies

The one-week course program aims to familiarize students with non-viral gene delivery and to learn diverse strategies for evaluating lipid nanoparticle formulations. In the process, students will prepare lipid nanoparticles that contain DNA as cargo using microfluidics. Various lipid particles with distinct physicochemical characteristics will be studied using dynamic light scattering, *in vitro* assays involving HepG2 cells, flow cytometry (FACS), confocal microscopy, and assays to quantitatively measure cellular uptake and transfection efficacy. Cell viability will be assessed using the MTS assay.

The students will get a first insight into the theory and practical application of LNPs for

gene delivery. They will manufacture LNPs and use them to transfect liver-derived cells.
Goals of the Course:

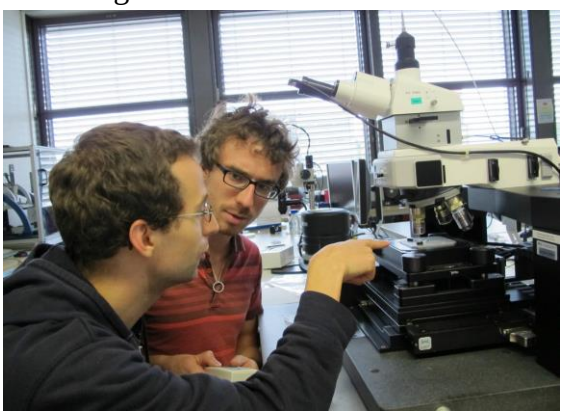
- The students are familiar with non-viral gene delivery methods using LNPs to transfect carcinogenic liver cells.
- The students are familiar with manufacturing of LNPs and know how to characterize them using different analytical methods.
- The students know how to measure cellular uptake and transfection efficacy using flow cytometry and confocal microscopy.
- The students know how to determine cell viability with *in vitro* methods (MTS).

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. The students will get a broad introduction into the theory and practical application of modern sensing technologies. The practicum includes the activation and functionalization of sensors and study of (bio-)molecule interactions The course is composed of the following tasks which have to be addressed during this one week practical training:
1) Gold-NP synthesis for sensor applications
2) Sensor surface cleaning and activation
3) Chemical functionalization of surfaces and immobilization techniques to couple biomolecules to functional surfaces
4) Applications in biosensing: e.g. a) quartz crystal microbalance, b) biolayer interferometry, c) lateral flow assay, d) biomolecular affinity measurements

The one week course will introduce the students to most recent methods for surface functionalization of common sensing platform materials e.g. glass, silicon or gold on glass. The students will learn about the very critical issue of surface cleaning and the effect on surface functionalization and will perform silanization reactions, self assembled monolayers based on thiol chemistry, layer by layer coating and functionalization by chemical bonding.
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. 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 and has to be considered comparing results from different sensing technologies.



The course is structured in separate experiments exemplifying functionalization and (bio-)sensing techniques and applications, i.e. “layer-by-Layer” functionalization and quartz crystal microbalance based mass sensing, chemical activation, covalent biomolecule functionalization and biolayer interferometry for biomolecular affinity measurements as well as nanoparticle synthesis, functionalization and application for lateral flow assays.

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:

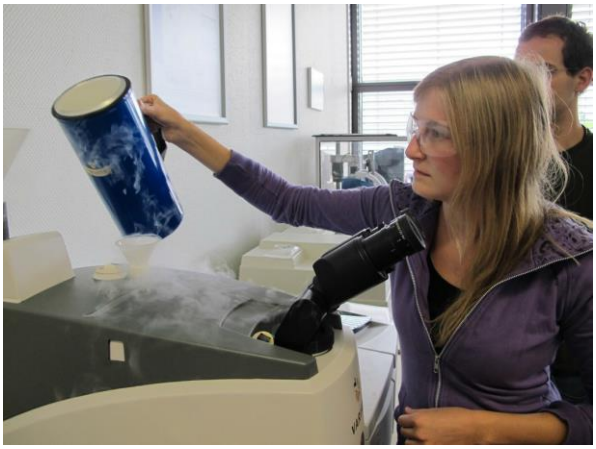
- Morphological modification of material surfaces (e.g. sandblasting, shot-peening, electropolishing and etching)

-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.

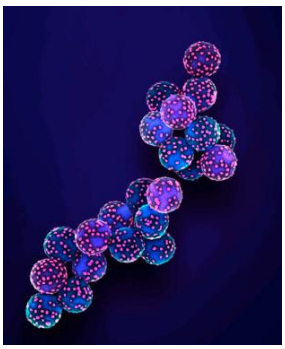
Goals of the course:

-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.

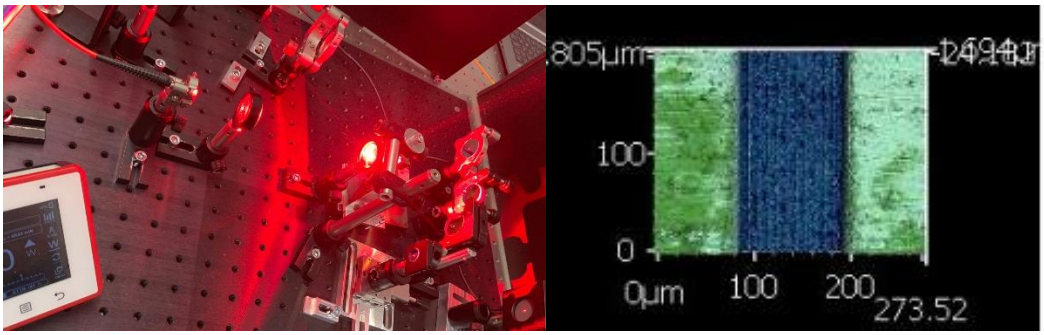
FHNW Windisch

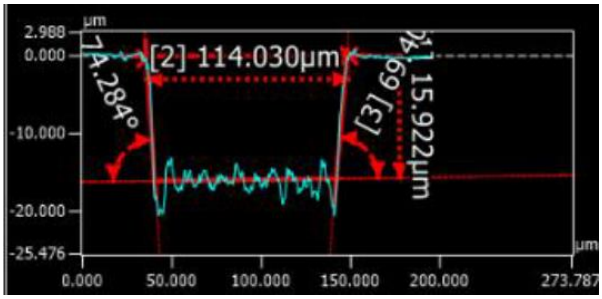
36. Femtosecond lasers, optical microscopy and Optical Coherence Tomography

Bojan Resan

FHNW School of Engineering, Institute for Product and Production Engineering

Pro Kurs 4 Students





Today, the main light source for optical microscopy is a laser, and for advanced methods a femtosecond (ultrafast) laser is required. Therefore, to understand the capabilities and limitations of optical microscopy, we will start with introduction to laser, followed by description of main concepts of femtosecond lasers. In the third lecture we will explain the general aspects and terminology of an optical imaging system. The fourth lecture will cover the confocal (linear) and multiphoton (non-linear) microscopy. In the last lecture we will describe the novel (recent Nobel Price winning) super-resolution microscopy and Optical Coherence Tomography.

The course is 5 days, divided into 2-3 theoretical lectures in the morning, followed by 3-5 hours of practical exercises in the afternoon, where the students will work hands-on and measure various parameters of lasers and microscopes.

The goal is that after this course students understand the principles of laser, femtosecond laser, and general imaging system; and they can decide if confocal, multiphoton, or super-resolution microscope is suitable for their needs and budget.

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@p

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, small angle neutron scattering 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 led to the Nobel prize awarded to C.G. Shull in 1994.
- Soft matter is used in many aspects of life, for example in food and health care. Small angle neutron scattering (SANS) allows to gain access to structures much larger than the neutron wavelength, which typically lies in the range from 1 Å up to 20 Å. SANS is thus used to probe features with a typical size in the range from 1 nm up to 150 nm in all kinds of materials including soft matter. In your experiment you'll study one such example and observe the micellization of a surfactant.

- Two dimensional materials is an important class of materials that is heavily study for their fundamentally novel properties. Often, such materials are made as thin films or multilayers. Neutron reflectometry is a powerful tool to investigate the depth dependence of 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 multilayers.

[1] http://www.psi.ch/sinq
[2] Andrew T. Boothroyd, "Principles of Neutron Scattering from Condensed Matter", Oxford University Press, Higher Education (2020)

26. µSR spectroscopy of magnetic and superconducting materials

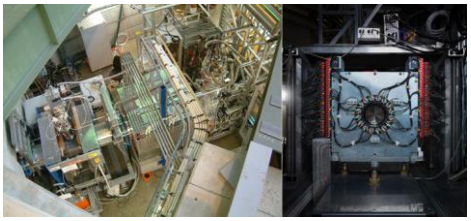
H, Luetkens, T. Prokscha

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/73526/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)

EMPA

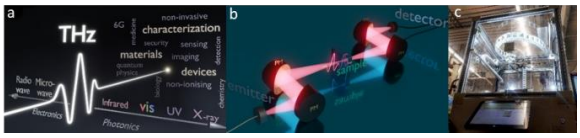
25. Exploring the THz regime

E. Mavrona, M. Dimitrievska, M. Calame

Location: Empa, Ueberlandstrasse 129, 8600 Dübendorf

Min. 2, max. 2 Students

Electromagnetic waves in the Terahertz (THz) regime form a non-invasive and non-ionizing radiation. Many exciting phenomena can be investigated using THz radiation, ranging from molecular vibrations in biochemical systems to ultrastrong light-matter coupling in quantum systems. Being at the boundary between optics and electronics, the THz regime has generated an increasing interest in the last decades thanks to new sources and detectors. To make THz technology more accessible today however, new sensitive and cost-effective THz devices need to be developed.



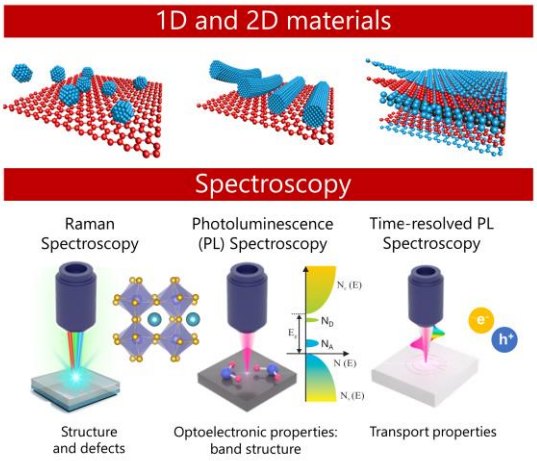
a) The THz regime b) A blender illustration of a THz time-domain spectroscopy c) The 3D printer that will be used for this work.

In this course, you will learn basic methods for developing and characterizing THz devices. You will be able to fabricate samples and devices such as THz lenses using microfabrication techniques, spin-coating, and 3D printing using different materials, for instance cyclic olefin copolymer, which is transparent from VIS to THz regime and 2D materials such as graphene. You will also become familiar with THz technology using THz characterization techniques, including THz time-domain spectroscopy and THz nanoscopy for imaging of the samples that you will prepare during the course.

Further information:
Dr Eleni Mavrona, Dr. Mirjana Dimitrievska, Prof. Dr. Michel Calame
https://www.empa.ch/tnilab

40. Raman and photoluminescence spectroscopy at the nanoscale

Angel Labordet, Mirjana Dimitrievska, Michel Calame
Location: Empa, Ueberlandstrasse 129, 8600 Dübendorf
Min. 2, max. 3 Students



Atomically precise, thin, low-dimensional (LD) materials are promising candidates as building blocks of future electronics, optoelectronic and quantum devices. Nanoscale characterization techniques are the key for unveiling the fascinating properties of these materials, such as controllable bandgap and strong light-matter interaction, leading to their successful integration in devices. Optical spectroscopy, such as Raman and photoluminescence, as well as time domain spectroscopy, such as time-resolved photoluminescence, offer a unique way to simultaneously probe structural and optoelectronic properties, as well as carrier dynamics.

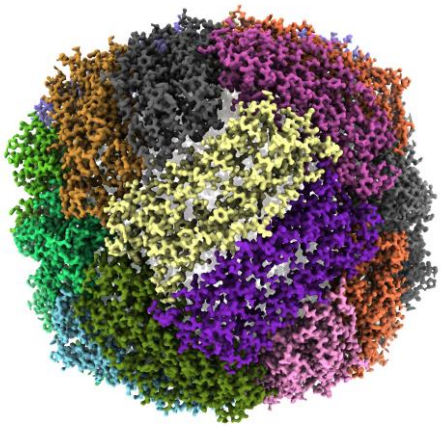
In this course, you will learn the basic principles of Raman, photoluminescence and time-resolved photoluminescence spectroscopy, as well as have the opportunity to deep dive in the exciting world of 1D and 2D materials, such as graphene nanoribbons, graphene mono and bi-layers, as well as transition-metal dichalcogenides (MoS2 and WSe2).

Further information:
Dr. Mirjana Dimitrievska, Prof. Dr. Michel Calame
https://www.empa.ch/tnilab

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.