EPFL

Project updated: 03.06.2021

Thermal scanning probe lithography for 2D material-based devices

Semester project / Master project

(Section: microengineering, material science, mechanical engineering, physics microelectronics)

Traditionally, 2D material (2DM) devices are patterned using electron beam lithography. However, electrons can easily damage the delicate 2DM and you typically need to fabricate alignment marks to overlay the patterns with the 2DM buried under the resist.

Here, we propose the use of thermal scanning probe lithography (t-SPL), a lithographic tool that uses a hot sharp tip to create nanometer-sized patterns (see Fig. 1). T-SPL avoids the use of electrons and offers precise overlay and marker-less stitching thanks to its capability of in-situ inspection. Besides, the same tool offers laser direct writing (DLW) to speed up the fabrication of microscale patterns (see Figs. 1c-d). 3D patterning can be also easily achieved by creating a design in greyscale that will translate into different depths of patterning, such as Fig. 1f

In this experimental project, the student will be able to use t-SPL for the fabrication of 2DM devices. The project can be adjusted to the student's interests.

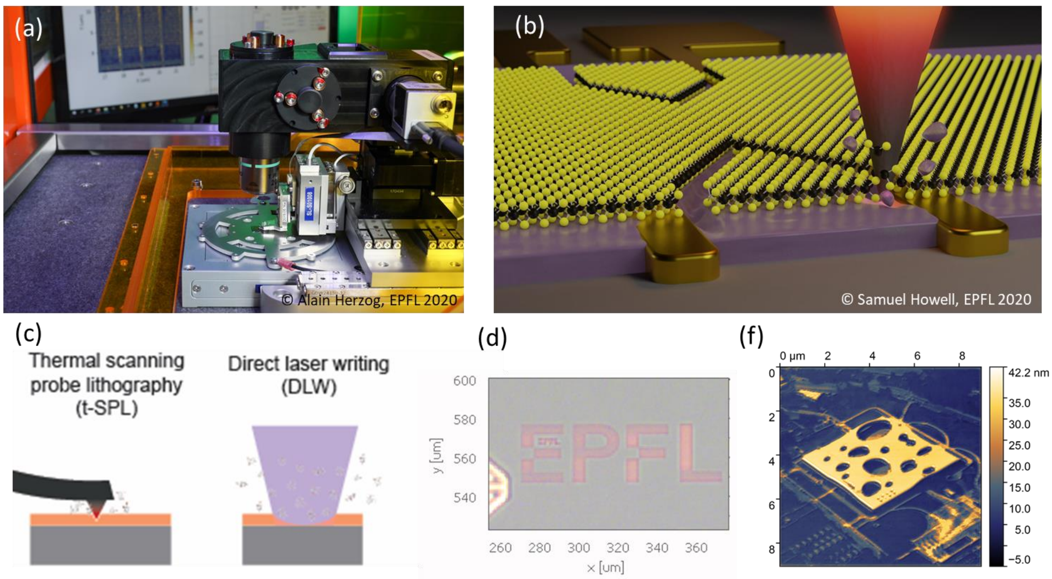


Figure 1. Main idea and scheme of the process.

Work description:

- Use of tSPL to define nanometer scale patterns
- Use of DLW to create microscale patterns
- Combination of tSPL and DLW for a functional device by using pattern transfer (etching) or lift-off (e.g. creation of electrodes)

Contact: Ana Conde Rubio *(ana.conderubio@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1 (Prof. J. Brugger)

EPFL STI IMT LMIS1 (Batiment BM) Station 17 CH - 1015 Lausanne

Phone : +41 21 693 10 59
E-mail : ana.conderubio@epfl.ch
Office : BM 3.114

Project updated: 03.06.2021

Thermal Scanning Probe Lithography Patterning for Straining 2D Materials

Semester project / Master project

(Section: microengineering, material science, mechanical engineering, physics, microelectronics)

The emerging field of 2D materials (2DM) is growing exponentially thanks to their extraordinary properties that find applications in very diverse fields. For example, it is well known that strain can be used to tune the bandgap and the optoelectronic properties of 2DMs. However, currently, the values for strain reported in literature are still limited which hinders in turn the bandgap tuning. In this project, we propose to transfer 2D materials (monolayer) onto the prepatterned PPA substrate, such as sinusoidal waves in Fig 1 and 2 and other patterns. The PPA substrate is patterned using Thermal Scanning Lithography (t-SPL).

The main goal of the project is experiments including fabrication, characterization, etc. The project can be adjusted to the student's interest, eventually.

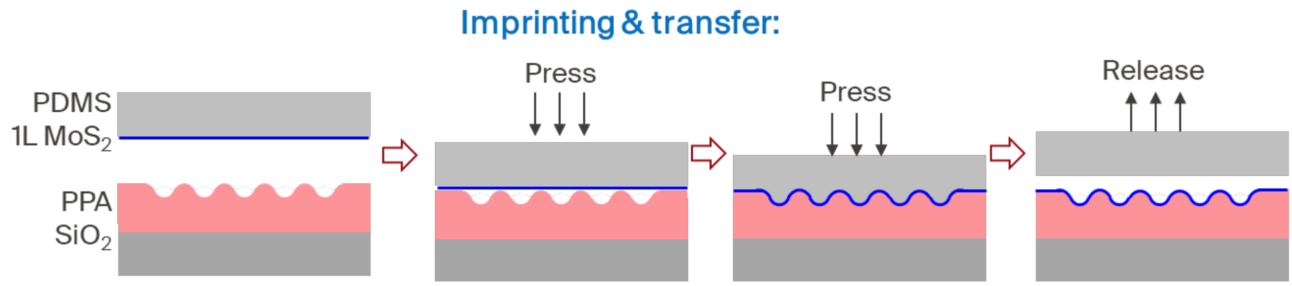


Figure 1. Main idea and scheme of the process.

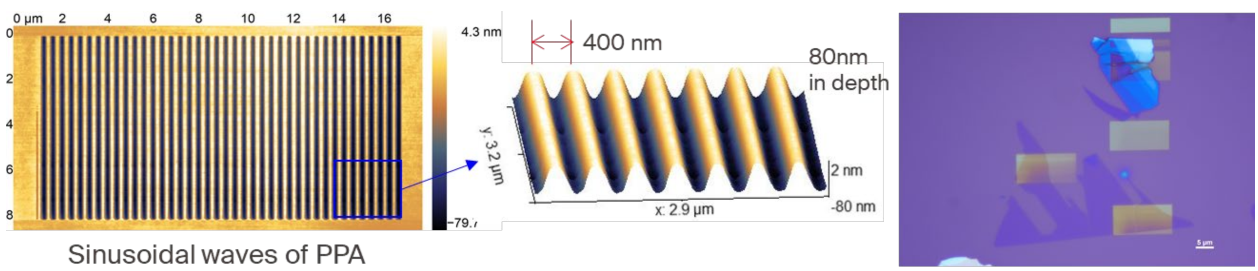


Figure 2. Preliminary results about t-SPL pattern and the 2D transfer.

Work description:

- t-SPL pattern
- Preparation of 2D material flakes
- characterization of strain in the 2D material

Contact: Xia Liu *(xia.liu@epfl.ch)*

EPFL STI IMT LMIS1 (Batiment BM)
Station 17
Phone : +41 21 693 10 59 E-mail : ana.conderubio@epfl.ch
Office : BM 3.114

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1 (Prof. J. Brugger)

CH - 1015 Lausanne

EPFL

Project updated: 04.06.2021

Spontaneously Formed Surface Micro-Wrinkles for Applications in Pattern Masks or Straining 2D Materials

Semester project / Master project

(Section: microengineering, material science, mechanical engineering, physics, microelectronics)

Methods for spontaneously forming periodic micro-/nanostructures have received considerable attention for lithography-free patterning applications. Self-organizing patterns with micrometer-scale features are promising for applications in photonics and bioengineering. Their spontaneous formation reduces the number of required processing steps. Previously, we developed an approach to spontaneously form stochastic patterns in thin skin layers on top of thermosensitive resist and an approach to align the micro-wrinkles. What's next, some demonstrations using the method will be interesting, for example, in the applications of fabrications of complex pattern masks, or straining atomically thin materials.

The main goal of the project is experiments including fabrication, characterization, modeling, etc. The project can be adjusted to the student's interest, eventually.

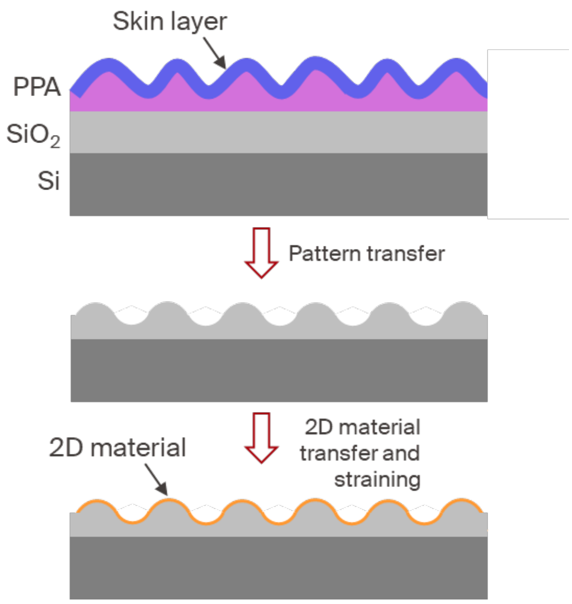


Figure 1. Main idea and scheme of the process.

Work description:

- Fabrication of wrinkles on other materials using plasma etching
- Preparation of 2D material flakes
- Characterization of strain in the 2D material

Contact: Xia Liu *(xia.liu@epfl.ch)*

EPFL STI IMT LMIS1 (Batiment BM)
Station 17
Phone : +41 21 693 10 59 E-mail : ana.conderubio@epfl.ch
Office : BM 3.114

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

CH - 1015 Lausanne

Project updated: 03.06.2021

Inducing strain in 2D materials with nanoimprint lithography

Semester project / Master project

(Section: microengineering, material science, mechanical engineering, physics microelectronics)

The emerging field of 2D materials (2DM) is growing exponentially thanks to their fascinating properties that find applications in very diverse fields. For example, it is well known that strain can be used to tune the bandgap and the optoelectronic properties of 2DM. However, currently, the values for strain reported in literature are still limited which hinders in turn the bandgap tuning and some methods used for inducing strain are limited in terms of scalability and others cannot properly control the induced strain. In this project, we propose the use of nanoimprint lithography to induce strain in 2DM in a controllable and scalable way.

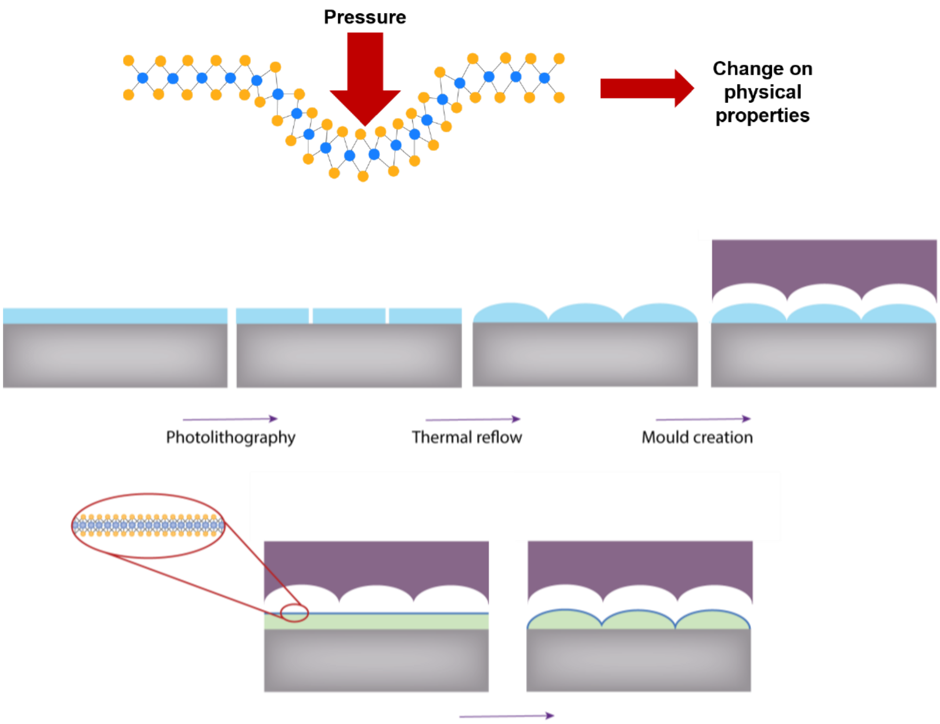


Figure 1. Main idea and scheme of the process.

Work description:

- Fabrication of stamps for NIL with wavy structures
- Use of the fabricated stamps for NIL to induce strain in 2D materials
- Characterization of the strain in 2D materials by Raman spectroscopy

Contact: Ana Conde Rubio *(ana.conderubio@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1 (Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 10 59
E-mail : ana.conderubio@epfl.ch
Office : BM 3.114

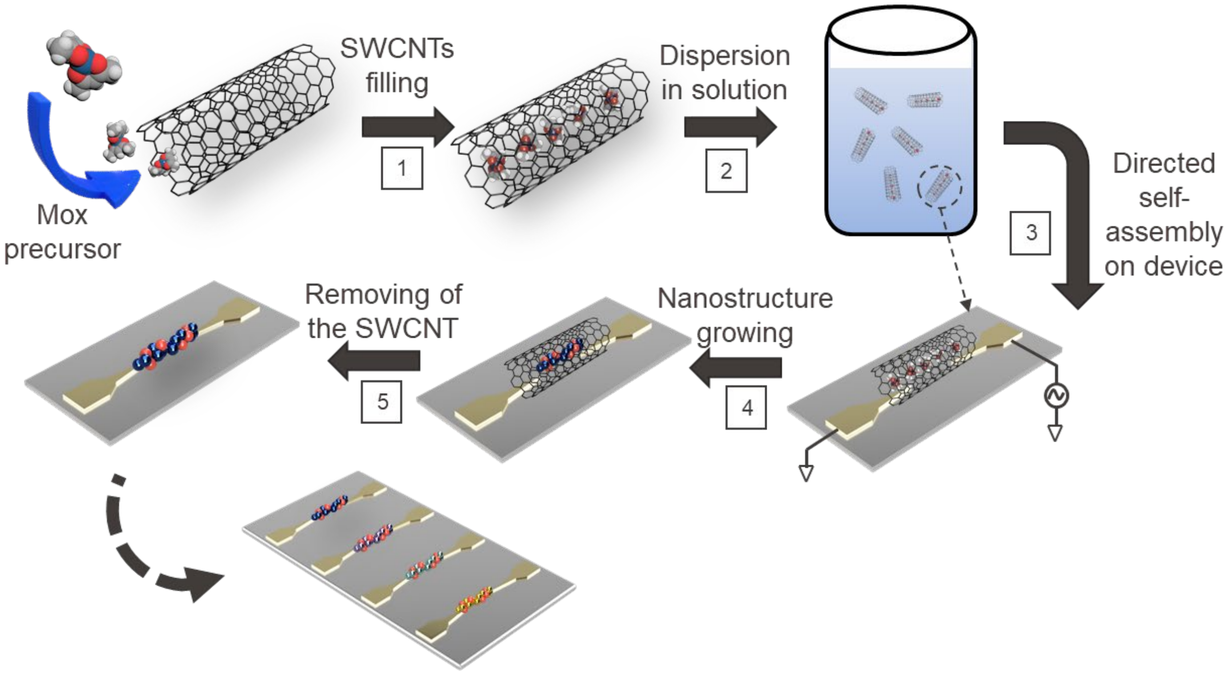
Electric-field-assisted self-assembly of nanohybrids for (bio)chemical sensing application

Semester project / Master project / Internship

(Section: microengineering, material science)

The student is welcome to choose the research aspect that he/she is the most interested in the following project.
We propose to control at the microscale the placement of nanohybrids at predefined locations with high-density by electric-field-assisted self-assembly. It is an alternative method that utilizes the interaction between a non-uniform electric field and the induced dipole of the nanohybrids. For this study, we will consider 2 types of nanohybrids:

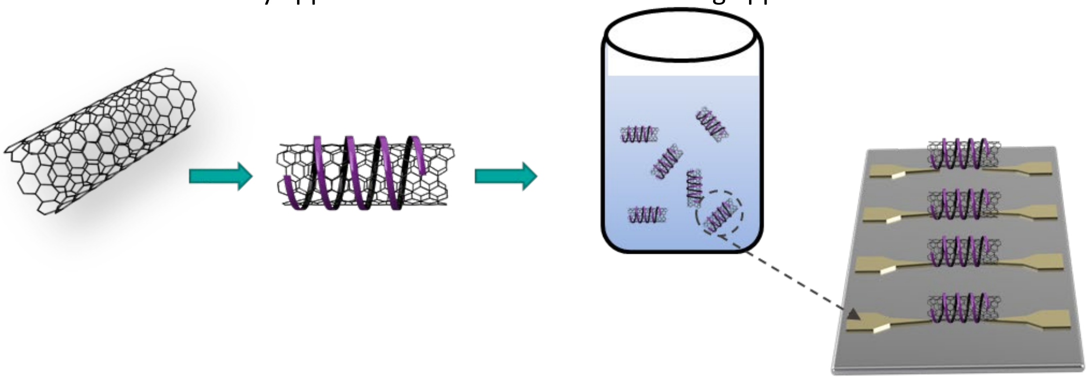
1) Growing of advanced metal oxide structures using single-walled carbon nanotubes (SWCNTs) as “nano test tubes” and vessels to allow their linear deposition between pairs of electrodes on a single electronic device for gas sensing application.



Scheme of the process.

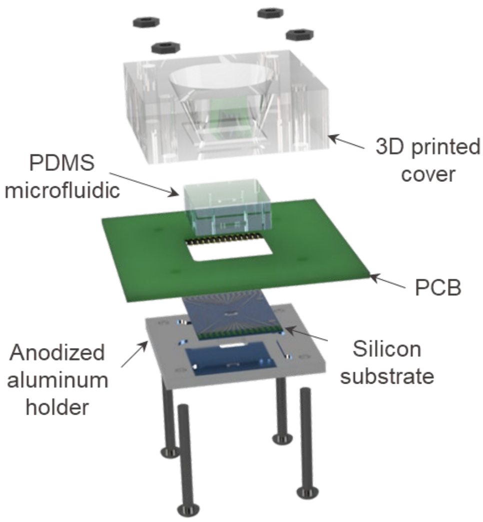
École polytechnique fédérale de Lausanne
Microsystems Laboratory 1
(Prof. J. Brugger)
EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne
Phone : +41 21 693 74 38
E-mail : pierrick.clement@epfl.ch
Office : BM 3.112

2) Coupling of artificial bioactive moieties such as DNA with semiconducting SWCNTs through supramolecular chemistry approaches in solution for biosensing application



Scheme of the process

The device is subsequently connected to a platform designed at the laboratory for electrical connection (no wire bonding) and sensing properties study has shown below.



Work description:

- Growing of metal oxide nanostructures as described in 1) with high vacuum sealing system
- Microfabrication of the silicon chip to host the nanohybrids
- Topography characterization of the nanohybrid immobilization by AFM
- Electrical characterization: Field-effect transistor configuration, I-V curves
- Chemical sensing of toxic gases and/or biomarkers

Contact : Pierrick Clément *(pierrick.clement@epfl.ch)*

Project updated: 23.12.2018

Inkjet printing polymer and polymer composites for wearable VOC sensors

Semester Project, Master Project

(Section: microengineering, electrical engineering, material science)

In the era of the internet of things (IoT), the demand for low-power and cost-effective wearable sensors towards personalized medical and consumer devices has been growing. Among them, sensors capable of detecting volatile organic compounds (VOCs) are of particular interest owing to their applications in personalized health care and consumer devices. Among different sensing materials, polymer and polymer composites can be used for the room temperature and selective detection of VOCs. The polymer-based VOC sensors are low cost, relatively simple to process, operate at room temperature, and are compatible with flexible substrates. Such advantages make them suitable candidates for IoT-enabled wearable applications.

This project aims to develop a wearable VOC sensor composed of multiple sensing elements made of polymers and polymer composites. The sensors will be fabricated additively using Drop-on-Demand inkjet printers (DOD IJP). DoD IJP can is be used to deposit the conductive tracks and the sensing material, providing a high degree of flexibility in the sensor design.

The choices for the flexible substrate include polyimide, PEN, PET, or SEBS. The first step is to optimize the surface functionalization of the substrate. Subsequently, the conductive tracks will be designed and printed onto the substrate, followed by the deposition of the sensing materials. The fully printed sensors will be characterized by exposing them to different VOCs.

Work description:

- Surface functionalization and characterization of the flexible substrate
- Inkjet ink formulation
- Sensor fabrication using Drop-on-Demand inkjet printing
- Characterization of the sensor response upon exposure to different volatile organic compounds (e.g., alcohols, ketones, hydrocarbons)

Contact: *Mohammad Kiaee (mohammadmahdi.kiaee@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1 (Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 41 77
E-mail : mohammadmahdi.kiaee@epfl.ch
Office : BM 3.111

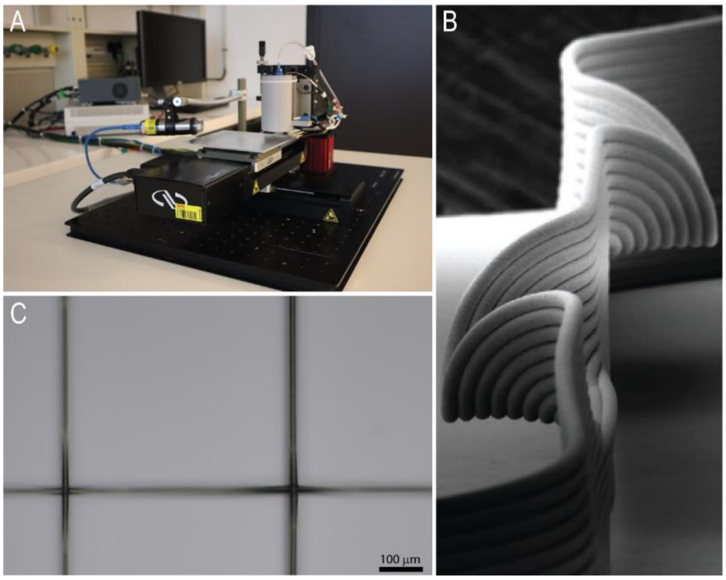
Project updated: 03.06.2021

Advanced additive manufacturing instrument development

Internship / Master Thesis / Master Project

(Section: microengineering, electrical / mechanical / material / computer science)

Melt electro writing (MEW) is an emerging high-resolution additive manufacturing technique for fibers, membranes and 3D objects in the micrometer range. MEW is related to solution electrospinning and allows the fabrication of continuous fibers with diameters of 1 – 50 µm, this is up to 10x smaller than for most other additive manufacturing techniques. Current and future applications of MEW include biomedical sciences, sensors, the textile industry, filtration technologies and many more.



A) MEW instrument at LMIS1 B) 3D MEW printed structure (adapted from Liashenko et.al. 2020) C) 2.5D printed "checkerboard" structure, 10 fibres stacked at intersection points

In the MEW process a polymer melt is expelled from a charged nozzle, forming a continuous fiber. This fiber is stabilized by an electric field and accumulates on an electrically grounded collector. Moving the collector according to a preprogramed trajectorydesign allows "printing" of patterns and structures. We recently built a MEW printer that allows for micro-metre sized 2D and 2.5D structures.

The goal of this student project is to further develop this instrument, including hardware, software and processing.

There are multiple project openings for master project, master thesis and internships available. Students with interest and experience in computer science and/or mechatronics are especially encouraged to apply. If more students are interested, we will define the work for a team.

Possible projects are:

- Creation of custom software for data collection, collector trajectory control and real-time parameter analysis and regulation
- Upgrading the instrument hardware to allow for full 3D printing, advanced processing control and improved environment regulation
- Development of printing processes for 2D and 3D structures with established and new materials.

Work description:

- Improvement of MEW setup and software
- Development of printing process

Contact: Prof. J. Brugger & Prof. Ch. Moser (LMIS-1 & LAPD)

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 6573
Email: juergen.brugger@epfl.ch

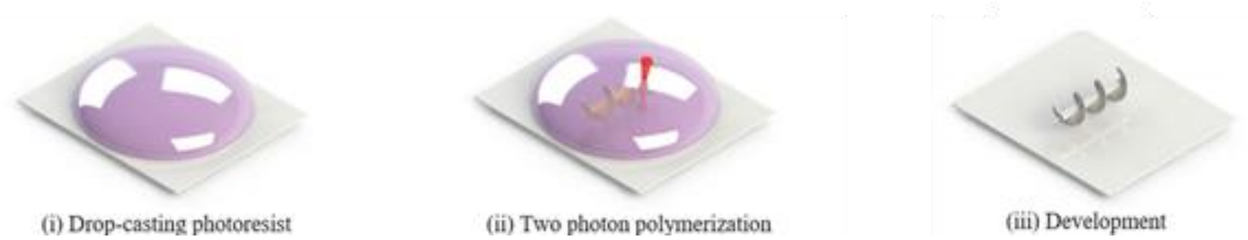
Project updated: 04.06.2021

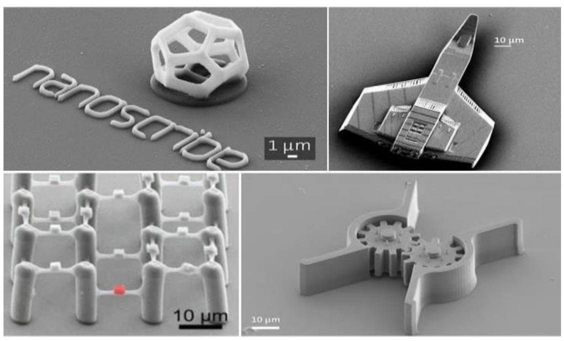
Fabrication of 3D biodegradable micro reservoir using two photon photolithography (Nanoscribe)

Semester project

(Section: microengineering, material science)

Development of two photon photolithography (TPP) enable us to fabricate delicate 3D microstructure. However, there are only few commercial photo resin for TPP in the market. For example, there is no commercial photo resin with biodegradable property. Biodegradable property is a critical property to be considered for *in-vivo* implantable micro devices such as implantable drug delivery devices. This project first goal is the development and optimization of PEGDA based biodegradable photoresist for TPP fabrication. And then optimization of the two photon photolithography printing condition for the biodegradable photoresist. Final goal of this project is fabricate biodegradable micro reservoir for implantable drug delivery device.





Work description:

- Development and optimization of PEGDA based photo resin for TPP
- Optimization of printing parameter for TPP
- Fabrication of biodegradable micro reservoir

Contact: Jongeon Park *(jongeon.park@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 53 37
E-mail : Jongeon.park@epfl.ch
Office : BM 3.109

Project updated: 11.06.2021

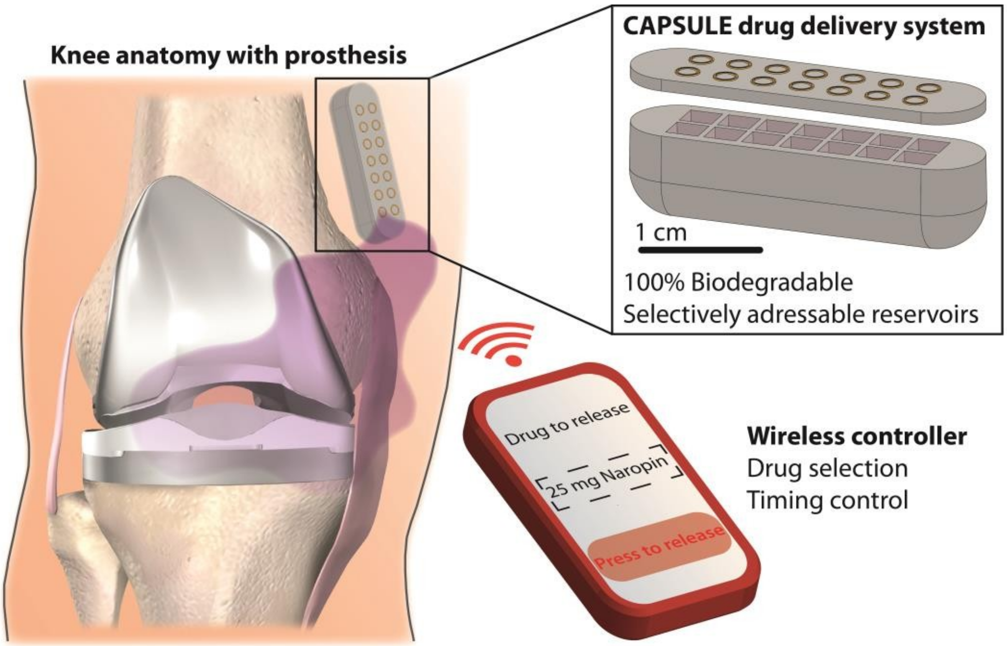
Bonding-in-liquid technique for biodegradable drug delivery capsules

Semester Project

(Sections: microengineering, material science)

Drug delivery systems (DDS) are engineered in order to improve therapeutic performance of oral pills and repeated injections. Fabricating DDS out of biodegradable materials enables these devices to be naturally eliminated by the body once their function completed. There exist several biodegradable polymers which naturally degrade by hydrolysis in a biological environment and which degradation rates can be easily tuned from a few weeks to several months.

The goal of this project is to develop a bonding-in-liquid technique for liquid encapsulation into biodegradable polymeric drug delivery capsules. Throughout this project, you will gain experience with polymer processing and knowledge about biodegradable materials and drug delivery systems. Hence, we are looking for a highly motivated student with a strong interest in biomedical engineering and material science.



Work description:

- Fabrication of biodegradable polymeric capsules
- Development of a bonding-in-liquid technique for liquid encapsulation

Contact: Claudio Gonnelli *(claudio.gonnelli@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 58 17
E-mail : claudio.gonelli@epfl.ch
Office : BM 3.109

Project updated: 07.06.2021

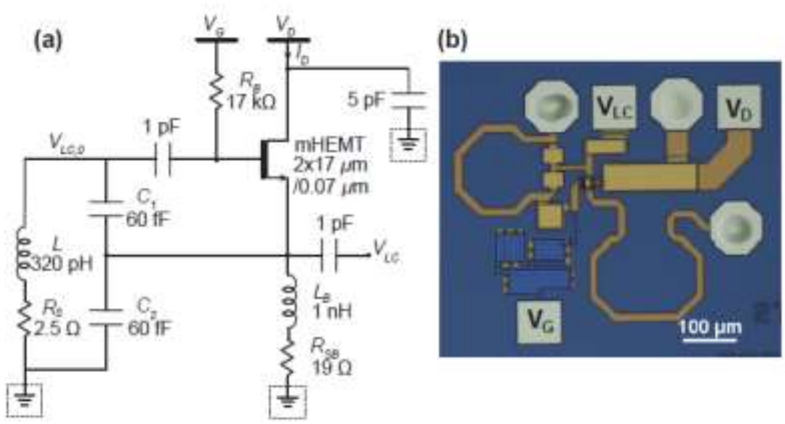
Cryogenic microwave oscillator design for electron spin resonance spectroscopy

Semester project / Master project

(Section: microengineering, electrical and electronic engineering)

Electron spin resonance (ESR) is a powerful and widely applied spectroscopic tool used in physics, chemistry, biology, and materials science to determine the structure and dynamics of compounds with transition metal ions, free radicals, triplet states, and defect centers. Due to the broad range of potential applications, it is important to improve the conventional inductive techniques and develop new detection methods for high sensitivity ESR spectroscopy in the sub-nanoliter range.

In this project, we aim at the realization of inductive electron spin resonance detectors, operating in a broad frequency (10 GHz to 300 GHz) and temperature range (0.3 K to 300 K), capable to achieve significantly better spin sensitivities than those reported to date. Extending the frequency and the temperature range increases both the sensitivity and the possible applications. In particular, we will design microstrip microwave oscillators to: (1) study and improve their limit of detection, (2) perform ESR experiments beyond the sensitivity limitations of inductive systems.



A previously designed single-chip ESR spectrometer [Sahin-Solmaz, 2021]

Work description:

- Microstrip microwave oscillator design using discrete components
- Characterization of the microwave oscillator at cryogenic temperatures
- Electron spin resonance measurements with the designed oscillator
- Project can be adjusted to the student's interests

Contact: Nergiz Sahin Solmaz *(nergiz.sahin@epfl.ch) and Reza Farsi (reza.farsi@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1 (Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 45 72
E-mail : nergiz.sahin@epfl.ch
Office : BM 3.111

Superconducting RF Resonators for Cryogenic Thermometry

Master project

(Section: Microengineering – Physics – Electric Engineering – Materials Science)

The operation of large cryogenic apparatus often relies on distributed temperature measurements. The well-established electric thermometers (4-wire approach) presents a series of inconveniences: feedthrough space requirement, risk of leaks, risk of electric breakdown, heat input (conduction in wires), need for thermalization, etc.. Allocating large number of thermometers or compensating for the absence of distributed thermometry imposes important constraints in the design of the apparatus.

At the LMIS1, we are currently investigating new possibilities of providing a temperature measurement system in cryogenic environment (T<10 K) by means of an RF resonator network [1]. Such a goal would be achieved by exploiting the superconductor's kinetic inductance and London penetration depth temperature dependencies inducing a frequency response of the resonator to temperature (figures 1 and 2).

This student project will contribute to developing temperature sensitive resonators, either by exploiting new materials (e.g. nitride-based LTS [3] (figure 3), nanostructuration, etc…) or by suggesting innovative RF designs, which will be then fully tested and characterized in cryogenic (T<10 K) environments using liquid He and cryostat apparatuses. The topic is highly multidisciplinary, involving aspects of condensed matter physics, RF electronics design and test, cleanroom microfabrication and materials science: the focus can be adjusted depending on the student's preferential interests, best knowledge, previous experience and motivation.

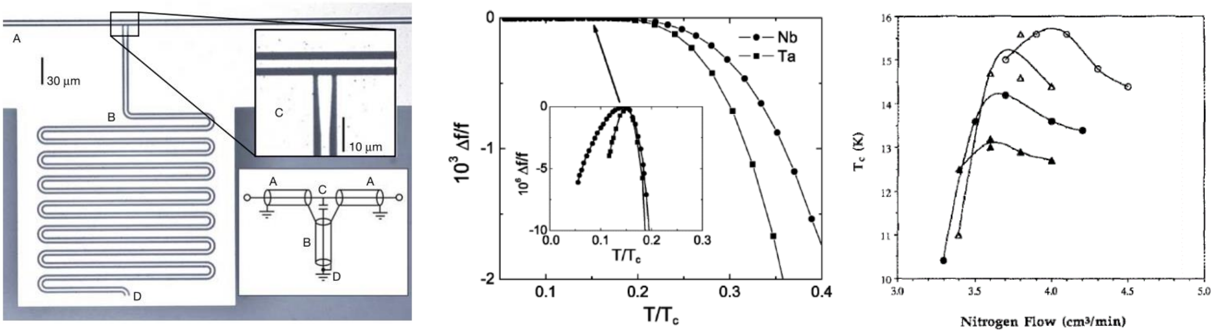


Figure 1 : *Thin film, superconducting coplanar waveguide resonators. Left: pattern example of a CPW resonator kinetic inductance sensor [1]. Center: frequency shift of low temperature superconductor thin film resonators [2]. Right: NbN critical temperature variation with respect to sputtering Nitrogen-flow for different process pressures [3].*

Possible tasks:

- Simulate and analyze superconducting RF coplanar waveguide components and resonators.
- Design, optimize and/or execute process flows at EPFL's state-of-the-art CMi cleanroom:
  - Process flow conception,
  - Drawing individual devices and aggregated chip/wafer lithography layouts,
  - Characterization of the resulting components using SEM, AFM, and other metrology tools.
- Optimize processing and materials for pushing patterning resolution and resonator thermal sensitivity.
- Cryo-RF characterization of finalized devices in a cutting-edge experimental setup.

Contact: André Chatel *(andre.chatel @epfl.ch)*
Hernán Furci (*hernan.furci@epfl.ch*)

[1] PK Day et al. (2003) Nature 425 817.
[2] Barends et al. (2007) IEEE Transactions on Applied Superconductivity 17(2).
[3] Westra et al. (1990) Journal of Vacuum Science & Technology A 8 (3).

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 90 42
E-mail : hernan.furci@epfl.ch
Office : BM 3.112

Project updated: 09.06.2021

Superconducting RF Resonators for Cryogenic Thermometry

Semester project

(Section: Microengineering – Physics – Electric Engineering – Materials Science)

The operation of large cryogenic apparatus often relies on distributed temperature measurements. The well-established electric thermometers (4-wire approach) presents a series of inconveniences: feedthrough space requirement, risk of leaks, risk of electric breakdown, heat input (conduction in wires), need for thermalization, etc.. Allocating large number of thermometers or compensating for the absence of distributed thermometry imposes important constraints in the design of the apparatus.

At the LMIS1, we are currently investigating new possibilities of providing a temperature measurement system in cryogenic environment (T<10 K) by means of an RF resonator network [1]. Such a goal would be achieved by exploiting the superconductor’s kinetic inductance and London penetration depth temperature dependencies inducing a frequency response of the resonator to temperature (figures 1 and 2).

This semester project will contribute to developing temperature sensitive resonators, either by exploiting new materials (e.g. nitride-based LTS [3] (figure 3), nanostructuration, etc…) or by exploring innovative RF designs, eventually fully tested and characterized in cryogenic environment using liquid He and cryostat apparatuses. The topic is highly multidisciplinary, involving aspects of condensed matter physics, RF electronics design and test, cleanroom microfabrication and materials science: tasks can be adjusted depending on the student’s preferential interests, best knowledge, previous experience and motivation.

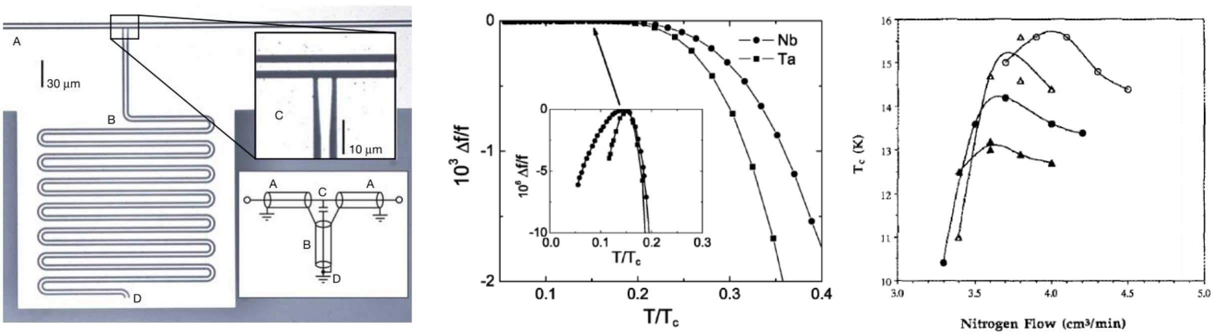


Figure 1 : *Thin film, superconducting coplanar waveguide resonators. Left: pattern example of a CPW resonator kinetic inductance sensor [1]. Center: frequency shift of low temperature superconductor thin film resonators [2]. Right: NbN critical temperature variation with respect to sputtering Nitrogen-flow for different process pressures [3].*

Possible tasks:

- Model and analyze superconducting RF coplanar waveguide components and resonators.
- Characterization of the resulting components using SEM, AFM, and other metrology tools.
- Model and analyze processes and materials for pushing patterning resolution and resonator thermal sensitivity.
- Characterize finalized devices in a cutting-edge Cryo-RF experimental setup.

Contact: André Chatel *(andre.chatel @epfl.ch)*
Hernán Furci (*hernan.furci@epfl.ch*)

[1] PK Day et al. (2003) Nature 425 817.
[2] Barends et al. (2007) IEEE Transactions on Applied Superconductivity 17(2).
[3] Westra et al. (1990) Journal of Vacuum Science & Technology A 8 (3).

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 90 42
E-mail : hernan.furci@epfl.ch
Office : BM 3.112

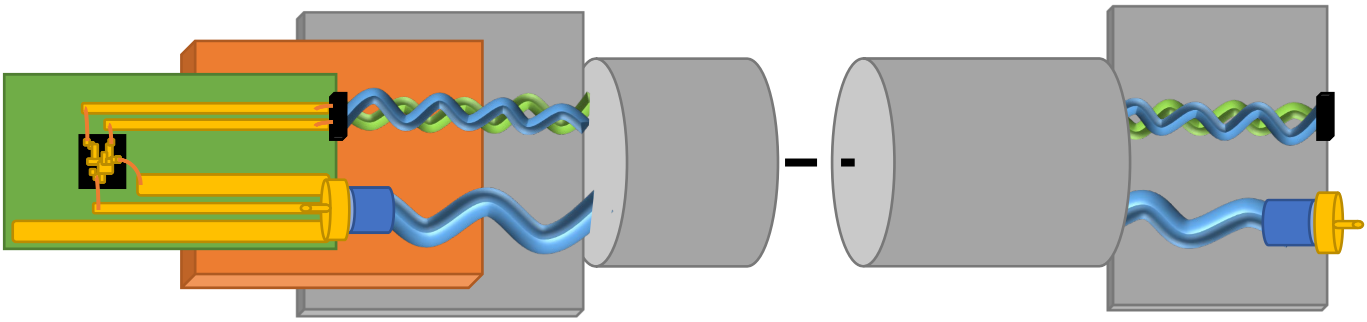
Project updated: 05.06.2021

Design, realization and testing of a cryogenic probe for sensors characterization

Semester project / Master project

(Section: microengineering, mechanical engineering, physics, microelectronics)

The low temperature characterization is of paramount importance in some fields and for some sensors. A proper characterization requires an optimized probe system used to expose the sample to a low temperature environment, allowing at the same time to retrieve in real time the information of interest from the sensor under test. This project aims at designing and testing a low temperature probing system, both for RF and DC signals, to be used with dewars of liquid nitrogen (LN2, 77K) and dewars of liquid helium (LHe, 4K), starting from the requirements forced by the environment and by the sensors to be characterized.



Work description:

- Requirements analysis
- Design of the probe, mechanical end electronics parts (DC and RF)
- Realization of the probe
- Testing of the probe in LN2 / LHe by characterization of one of the sensors it was designed for.

Contact: Roberto Russo *(roberto.russo@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 42 19
E-mail : roberto.russo@epfl.ch
Office : BM 3.113

Project updated: 03.06.2021

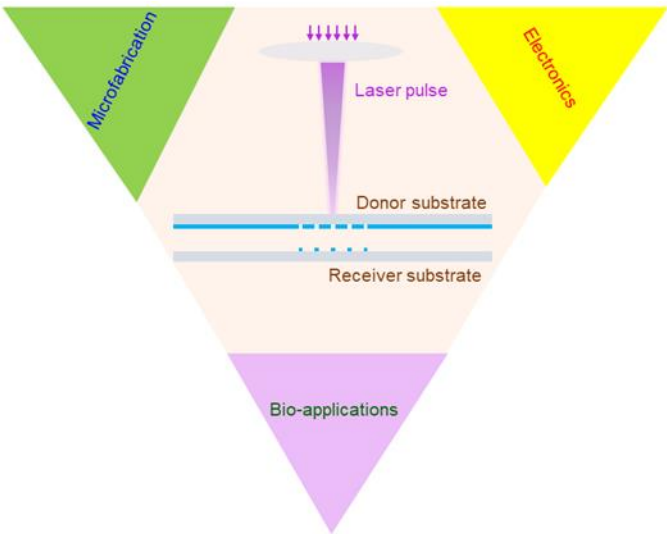
Laser-induced forward transfer for SU-8 epoxy resin printing

Semester project

(Section: microengineering, material science)

Laser-induced forward transfer (LIFT) is a digital manufacturing technology which allows printing materials in a serial manner following a predesigned pattern. It is a direct-write technique that enables the deposition of small volumes of material into user-defined, high-resolution patterns with a wide range of structural and functional materials. Compared to other printing techniques, LIFT is very competitive due to its mask/mold-free, non-contact, material diversity, nozzle-free nature. With such advantages, LIFT is a good candidate to print fluids with highly nonlinear rheological properties like polymers and colloidal suspensions, which might be challenging for other nozzle-based technologies.

The goal of this project is to investigate the printability of SU-8 epoxy resin by LIFT. We will study parameters that influence the printing results and take this as a reference for printing other viscous fluids by LIFT.



Work description:

- Prepare donor substrates (dynamic release layer + SU-8 inks).
- Investigate the parameters that influence the printing results such as the laser fluence, donor-receiver gap distance, receiver types, etc.
- Optimize the LIFT parameters to achieve stable LIFT printing of SU-8 and obtain a high printing resolution.

Contact: Zhiwei Yang *(zhiwei.yang@epfl.ch)*

École polytechnique fédérale de Lausanne
Microsystems Laboratory 1 (Prof. J. Brugger)
EPFL STI IMT LMIS1 (Batiment BM) Station 17 CH - 1015 Lausanne
Phone : +41 21 693 24 44
E-mail : zhiwei.yang@epfl.ch
Office : BM 3.113

Project updated: 11.06.2021

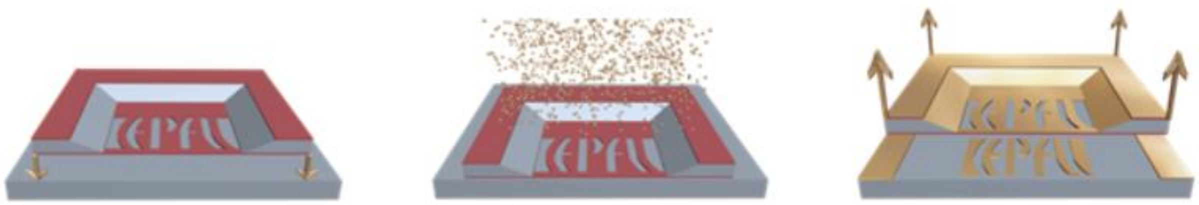
Stencil lithography

Semester Project / Master Project

(Section: microengineering, material science)

Stencil lithography is a high resolution shadow-mask technique used for structuring micro and nanometer structures. The principal of it is to use shadow mask (stencil) to locally define atoms or molecules onto substrate. It serves a lot of advantages such as allowing for processing on biocompatible and biodegradable substrates due to its resistless property, easy manipulation and implementation.

The goal of this project will be systematically studying the behavior of the deposited biodegradable metals on biodegradable substrates for implantable applications by using stencil lithography.



Work description:

- Design and fabrication of stencil test keys.
- Hands-on e-beam evaporator with stencil (LMIS1 lab facilities).
- Geometrical and electrical characterization of deposited biodegradable structures.

Contact: Jürgen Brugger *(juergen.brugger@epfl.ch)*

École polytechnique fédérale de Lausanne

Microsystems Laboratory 1
(Prof. J. Brugger)

EPFL STI IMT LMIS1
(Batiment BM)
Station 17
CH - 1015 Lausanne

Phone : +41 21 693 65 73
E-mail : juergen.brugger@epfl.ch
Office : BM 3.107