GIANT INTERNATIONAL INTERNSHIP PROGRAMME

PROPOSED INTERNSHIP PROJECTS

2022

(Note: Project numbers have been re-ordered for Penn-GIANT administration use and are not in numerical order; please identify your project rankings by their project # and name)

PROJECT 5 – SURFACE NANOENGINEERING FOR STUDYING PROTEIN ADHESION

Supervisor's name

- Supervisor 1: David MUÑOZ-ROJAS
- https://sites.google.com/site/workdmr/

GIIP Intake: Ideally from February to July or Summer 2022 (May to July/August)

Institute: Grenoble-INP

Laboratory: Materials and Physical Engineering Laboratory (LMGP)

Keywords: Spatial Atomic Layer Deposition. Protein adhesion, surface nanoengineering. Thin film deposition and characterization.

Description of the project:

The aim of the project is to deposit by spatial atomic layer deposition (SALD) a thin film (20 nm) of metal oxides (MeOx) on surface sensors, covered with a gold layer. These sensors are gold-coated prisms for Surface Plasmon Resonance (SPR) and quartz crystals for Microbalance (QCM) monitoring of protein binding on surfaces. Among MeOxs, SiO_2, TiO_2 and Al_2O_3 are interesting because silicates and aluminates are important constituents of many minerals

Methodology: MeOx thin films will be deposited by SALD at a temperature low enough to avoid gold delamination from the glass sensors. After deposition, thermal annealing will be applied to control the crystallinity of the samples. Sample structure will be studied by XRD and Raman spectroscopy. The surface chemical composition will be determined by XPS. The thickness of the MeOx layer will be measured by ellipsometry and the morphology of the thin film will be observed by electron microscopy. The MeOx thin films on the sensors will be assessed for their stability in contact with aqueous buffers and their compatibility with the sensing techniques.

Objectives: The outcome will be to extend the range of protein-materials interaction studied by Surface Plasmon Resonance to metal oxides that form the core of many minerals. The next goal will be

to vary grain size to study how it affects protein binding. These new surfaces will be extremely interesting to characterize the chemical specificity of different adhesion proteins derived from spider silks or barnacle cement proteins.

Scientific environment: The candidate will work within the LMGP, Materials and Physical Engineering Laboratory, both in the IMBM and the FunSurf teams. She/he will access a large variety of characterization techniques, either in the lab or at the Consortium des Moyens Techniques Communs. Located in the heart of an exceptional scientific environment, the LMGP offers the applicant a rewarding place to work.

We look for a student with a strong knowledge in material science and some interest for protein biochemistry and biophysical methods. The student should be able to work in a team, have good writing skills (report, presentation…) and a good knowledge of spoken and written English.

PROJECT 6 – RAMAN CHARACTERIZATION OF CU-BASED OXIDE THIN FILMS

Supervisor's name

- Supervisor 1: David MUÑOZ-ROJAS
- https://sites.google.com/site/workdmr/

GIIP Intake: Ideally from February to July or Summer 2022 (May to July/August)

Institute: Grenoble-INP

Laboratory: Materials and Physical Engineering Laboratory (LMGP)

Keywords: Spatial Atomic Layer Deposition. Cu-based oxides, Raman spectroscopy.

Description of the project:

We have recently demonstrate that Raman spectroscopy is a powerful tool to probe the defects in Cu-based oxide thin films (Commun Mater 2, 78 (2021)). The aim of the project is to use Raman spectroscopy to characterize different Cu-based oxide thin films.

Methodology: The thin films will be deposited by Spatial Atomic Layer Deposition by the candidate or by other members of the team. The films will then be subjected to different post deposition treatments. Both as-deposited and treated thin films will be characterized in depth by Raman Spectroscopy and their transport properties will be studied by 4-probe and Hall measurements

Objectives: Gain insight in the nature of defects presents in the film and its correlation with the transport properties of the films.

Scientific environment: The candidate will work within the LMGP, Materials and Physical Engineering Laboratory, both in the IMBM and the FunSurf teams. She/he will access a large variety of characterization techniques, either in the lab or at the Consortium des Moyens Techniques Communs. Located in the heart of an exceptional scientific environment, the LMGP offers the applicant a rewarding place to work.

We look for a student with a strong knowledge in material science and thin film deposition and characterization. The student should be able to work in a team, have good writing skills (report, presentation…) and a good knowledge of spoken and written English.

PROJECT 14 – POLYMER SYNTHESIS FOR SMART DRUG DELIVERY

Supervisors' name

- Supervisor 1: Dorothée JARY
- Supervisor 2: Antoine HOANG

GIIP Intake: Summer 2022 (May to July/August 2022)

Institute: CEA LETI

Laboratory: Laboratory of Chemistry, Sensors and Biomaterials (L2CB)

Keywords: UCST (upper critical solution temperature) polymer; microneedles

Description of the project:

Microneedles (MN) arrays offer a highly promising solution for crossing the skin barrier in order to deliver small molecular as well as macromolecular therapeutics. Drug delivery from MN arrays is most often based on soluble microneedles, which are dissolved once inserted into the skin. Our laboratory has a great experience in such kinds of devices, with industrial and clinical partnerships. However, this cannot apply to diseases requiring medications that must be dosed intermittently on demand and over a longer period of time. To address this issue, our laboratory develops a non-soluble stimuli responsive MN array system for on-demand delivery. One key parameter is the ability of the constitutive polymer of the MN to swell on demand after local heating, in order to release the active molecule. In this context, the intern will study the synthesis of a new UCST polymer able to form MN patch meeting these requirements. For this purpose, he will use the polymerization RAFT technique (Reversible Addition Fragmentation chain Transfert) which allows synthesis of polymers with low polydispersity index (PDI) and high functionality. The obtained target polymers will be analyzed by H-NMR and IR spectroscopies and applied in the projects.

PROJECT 7 – DEVELOPMENT OF A SPATIAL ATOMIC LAYER DEPOSITION SETUP

Supervisor's name

- Supervisor 1: David MUÑOZ-ROJAS
- https://sites.google.com/site/workdmr/

GIIP Intake: Ideally from February to July or Summer 2022 (May to July/August)

Institute: Grenoble-INP

Laboratory: Materials and Physical Engineering Laboratory (LMGP)

Keywords: Spatial Atomic Layer Deposition; Setup development; Part Design and fabrication; Mechatronics Engineering.

Description of the project:

Recently, a new approach to atomic layer deposition (ALD) has been developed that doesn't require vacuum and is much faster than conventional ALD. This is achieved by separating the precursors in space rather than in time. This approach is most commonly called Spatial ALD (SALD). In the LMGP we have are using and developing SALD as a novel gas-based 3D printing approach for functional materials. Printing materials with SALD allows nanometer resolution in Z while so far we reached several mm in XY (Advanced Materials Technologies, **2020,** 5 (12), 2000657.). We are currently further developing our system to decrease in resolution.

We are looking for a Mechatronics engineer to assist us with the development of our set up. The main aim will involve to implement heating regulations on different parts if the system and contribute to the automatization of the setup, as well as contributing to the design of different parts of the system. We are looking for a highly motivated student who is interested to work in an inter-disciplinary group and on an interdisciplinary project. Interpersonal skills, dynamism, rigor and teamwork abilities will be appreciated. The candidate should have Knowledge in Comsol or other CFD simulation tool, 3D printing. Knowledge in the OPTO22 system and software is desired. Experience in materials science and thin film deposition and characterization will be advantageous.

PROJECT 8 – DEVELOPMENT OF ARTIFICIAL INTELLIGENCE ASSISTANTS FOR SYNCHROTRON BEAMLINE DATA ANALYSIS

Supervisors' name

- Supervisor 1: Jean-Sébastien MICHA
- Supervisor 2: Samuel TARDIF

GIIP Intake: Summer 2022 (May to July/August)

Institutes: CEA IRIG

Laboratory: Modeling and Exploration of Materials Laboratory (MEM) / Nanostructures and Synchrotron Radiation

Keywords: Machine Learning, Artificial Intelligence, X-ray Image pattern, Data Analysis

Description of the project:

The aim of the internship is to dive into the exciting world of studies and characterization of materials at the European Synchrotron (ESRF) and the related advanced instrumentation for X-ray scattering. Due to the growing amount of data in synchrotron beamlines using rapid 2D detector new approaches to handle collected data from X-ray characterization measurements are needed. Over the last few years, Artificial Intelligence has entered into the synchrotron world with significant and promising results. Several demonstrations of Machine and deep learning algorithms and architectures were made for a higher general beamline throughput and better data interpretation by users. During the internship, we plan to test and implement various learning techniques on the analysis of x-ray 2D pattern recorded by Laue microdiffraction to enable on fly diagnosis & analysis. For instance, several assistants could be trained: to detect and sort data for further analysis, to perform regression for the determination of crystal orientation, to speed up the handling of complex or multicomponents scattering peaks, or deal with 2D (3D) microstructure reconstruction from sample raster scan. Sample or optics alignment procedures could also be implemented. Background on scientific computing is highly recommended. Knowledge on physics, materials science and crystallography would be an asset.

PROJECT 12 – UNDERSTAND IRON-SULFUR CENTER IN FUR

Supervisor's name

- Supervisor 1: Isabelle MICHAUD-SORET

GIIP Intake: Summer 2022 (May to July/August) or Autumn 2022 (September to December)

Institute: CEA IRIG

Laboratory: Laboratory of chemistry and biology of metals

Keywords: iron, metalloprotein, oxidative stress, iron-sulfur cluster

Description of the project:

The Ferric uptake transcription regulator (Fur) controls the expression of genes involved in iron homeostasis and virulence. In 2020, Fontenot et al. proposed that Fur binds a [2Fe-2S] cluster to 4 cysteines formerly considered as a structural zinc ligands. Our objectives are to decipher if iron-sulfur center in Fur is an artefact or a reality.

Iron is an essential micronutrient for fundamental cellular processes such as photosynthesis, N_2 fixation, and biosynthesis reactions. In most bacteria, the Fur metalloprotein is the transcriptional regulator that controls iron homeostasis by responding to iron concentration. In 2020, an article by Fontenot et al. proposed that Fur protein from Escherichia coli (EcFur) could bind a [2Fe-2S] cluster to sense intracellular iron homeostasis. They made a demonstration with different techniques that show the presence of a [2Fe-2S] center in a reddish EcFur protein only when purified from overproducing E. coli ΔiscA/ΔsufA double-mutant strains. These genes code for A-type carrier of [Fe-S] cluster present in classical [Fe-S] center biogenesis pathways. Coupling iron homeostasis, controlled by Fur, and [Fe-S] sensing and/or biogenesis could make sense and may open new perspectives.

Using complementary biochemical, biophysical and structural analyses our work will decipher if iron-sulfur center in Fur is a reality that may confer a new redox sensor function to this well-known global regulator.

We recommend a biochemical background and an interest for the role of metal in biology.

PROJECT 15 – VOLTAGE REGULATED VHF CONVERTER WITH INNOVATIVE EMBEDDED MATERIALS

Supervisors' name

- Supervisor 1: Xavier MAYNARD
- Supervisor 2: Sébastien CARCOUET
- Supervisor 3: Emmanuelle PAULIAC VAUJOUR

GIIP Intake: February 2022 onwards (5 to 6 months) can begin in April
Institute: CEA LETI
Laboratory: Energy & Power Electronics Lab (L2EP)

Keywords: power electronics

Description of the project:

Our laboratory carries out research in the domain of very high frequency converters. We have developed a patented resonant topology to minimize the voltage constraints on the passive and active components: the internship will focus on the converter control in order to address one of the main difficulty in such a converter, that is to say output voltage regulation. The aim is to achieve a high reliability converter, while addressing parameter constraints such as voltages, currents and temperature component withstanding. This kind of converter may be used as DC/DC power supply with a wide output voltage and power range in various applications, such as aeronautic, automotive or industrial. The trainee will first perform simulations to study the performance and limits of several voltage regulation loops. In a second step, she/he will implement the most interesting solution in a prototype. One key criteria is the limitation of the number of components: it will be addressed through the contribution and expertise of different CEA laboratories in both passive (inductance, capacitor) and active (GaN switches) components. The candidate must demonstrate strong skills in analogy and digital electronics and ideally in power electronics. A good knowledge of simulation tools (LTspice, PSPICE) and design tools (Altium) is required. Experience in software development (µC, DSP) and thermal calculation would be valuable.

Candidate profile: MSci in electronics or power electronics (BAC + 5)

Internship duration: 5 to 6 months

Perspective: PhD opportunity