MASTER DE CHIMIE DE PARIS CENTRE - M2S2
Proposition de stage 2020-2021
Internship Proposal 2020-2021

Parcours type(s) / *Specialty(ies) :*
☒ Chimie Analytique, Physique et Théorique */ Analytical, Physical and Theoretical Chemistry* :
☐ Chimie Moléculaire / *Molecular Chemistry* :
☐ Chimie et Sciences Du Vivant / *Chemistry and Life Sciences* :
☒ Chimie des Matériaux / *Materials Chemistry:*
☐ Ingénierie Chimique / *Chemical Engineering:*

Laboratoire d'accueil / *Host Institution*
Intitulés / *Name* : Laboratoire de Réactivité de Surface (LRS)
Adresse / *Address* : tour 43-33 3ème étage
Directeur / *Director (legal representative) : Hélène Pernot*
Tél / *Tel* : 01 44 27 55 33

Equipe d'accueil / *Hosting Team :*
Adresse / *Address :* tour 43-33 3ème étage
Responsable équipe / *Team leader* : Souhir Boujday
Site Web / *Web site :* http://www.lrs.upmc.fr/en/nanosurf-nanomaterials-surfaces-biointerfaces.html
Responsable du stage (encadrant) / *Direct Supervisor : Souhir Boujday/Juliette Blanchard*
Fonction / *Position : Professeure/chercheuse CNRS*
Tél / *Tel* : 0144276001/0144274914

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Période de stage / *Internship period* * : 18 janvier-16 Juillet 2020

Titre / *Title*
Multifunctional NanoComposites Confined within Plasmonic Shells for biological applications

Projet scientifique (1 page maximum) / *Scientific Project (maximum 1 page):*

1. Description du projet / *Description of the project*

Plasmonic nanoparticles, based mainly on **gold** and/or **silver** assemblies, play a major role in multiple biological applications including biosensing, drug delivery and theranostics. Their success is due to their unique optical features that originate from the Localized Surface Plasmon Resonance (**LSPR**), a phenomenon that results in a very intense absorption band in the visible range which wavelength can be monitored by UV-Visible spectroscopy, and depends, among other factors, on the nature of the metal and the nanoparticles' shape. In addition to this outstanding property they show on their own, plasmonic assemblies have proven to be efficient in **enhancing**, up to several orders of magnitudes, the responses of other functional materials. Therefore, huge effort has been devoted to their controlled combination with such materials.

In our group, we have developed an expertise in engineering a large panel of plasmonic nanoparticles ranging from spherical Gold or Silver, Hollow NanoShells, Gold Nanorods, Core-shell Gold Silver and

* min. 5 mois à partir du 18 janv 2021 / *min. 5 months not earlier than January, 18th 2021.*
Fin de stage au plus tard le 16/07/2021 ou le 30/09/2021 (dates de validation de diplôme). / *End of internship at the latest July 16, 2021 or Sept. 30, 2021 (dates of graduation).*

Silver Gold. We have recently demonstrated that Gold **Hollow NanoShells** (HNSs), can be used as a **nanoreactors** to run confined chemical reactions. Importantly, these plasmonic nanoreactors offer opportunities to spatially control chemical reactions by **nanoconfinement** effects as exemplified by the controlled growth of Silver nanoparticles exclusively at the inner walls HNSs.

In this project, we intend to use these Hollow shells to encapsulate functional particles and explore the input of plasmonic enhancement to their intrinsic properties. The particles we target herein are **UpConverting Nanoparticles** (**UCNs**), **Quantum Dots** (**QDs**), and **NanoDiamonds** (**NDs**). All three kinds have in common an external hydrophobic shell allowing for similar chemical pathways when it comes to their functionalization and further growth of plasmonic nanoshells at their surfaces. The first step towards this functionalization will be their coating by a thin layer of silica. In this internship, we intend to optimize the growth of the plasmonic hollow shell on silica and silica coated nanoparticles. Then, once the strategy is defined, we will explore the input of these structures to the LSPR biosensors, i.e. devices allowing the detection of a target based on the LSPR band. In addition, through established collaborations, with INRS (**Montreal, Canada**) for UCNs, LCP (**Orsay**) and ITODYS (**Paris**) for QDs, and UTT (**Troyes**) for NDs, we will explore the enhancement resulting from these nanocages to the intrinsic activities of the encapsulated nano-objects and we do expect a wealth of information on the mechanism plasmonic enhancements by these nanocapsules.

2. Techniques ou méthodes utilisées / *Specific techniques or methods*

The candidate will be able to master the colloidal particles synthesis as well as chemical grafting of the bioreceptors on nanoparticles and assessing the biosensor performances. Indeed, a particular attention will be paid to the elaboration of engineered nanoparticles that will be extensively characterized by different techniques (UV-Vis, DLS, zeta potential, TEM/STEM, EDX). Motivation, initiative and autonomy are required as well as good communication skills. Possible PhD. English is mandatory.

3. Références / *References*

1- Core-shell Gold Silver Nanoparticles for LSPR-Based Naked Eye Toxin Biosensing. Loiseau A.; Zhang, L.; Hu, D.; Mazouzi, Y.; Flack, R.; Salmain, M.; Liedberg, B.*; Boujday, S.*, *ACS Applied Materials & Interfaces* **2019**. https://doi.org/10.1021/acsami.9b14980

2- Naked Eye Immunosensing of Food Biotoxins Using Gold Nanoparticle-Antibody Bioconjugates. Zhang, L.; Salmain, M.; Liedberg, B.; Boujday, S.*, *ACS Applied Nano Materials* **2019,** *2* (7), 4150-4158. ***Cover.*** https://doi.org/10.1021/acsanm.9b00598

3- Spatially Controlled Reduction and Growth of Silver in Hollow Gold Nanoshell Particles, Zhang, L.; Chen, P.; Loiseau, A.; Brouri, D.; Casale, S.; Salmain, M.; Boujday S*; Liedberg, B*, *The Journal of Physical Chemistry C* ***2019,*** *123 (16), 10614-10621*, ***Cover*** https://doi/10.1021/acs.jpcc.8b11864

More on http://www.lrs.upmc.fr/en/nanosurf-nanomaterials-surfaces-biointerfaces.html