PhD offer

Cataplasm project : N-dealkylation of opioids in water catalyzed by metal porphyrins and enhanced by plasmonics

Description:

The project **Cataplasm** aims to propose a solution to the problem of water contamination by opioids that are not removed/degraded by traditional water treatment. The abuse of synthetic opioids has reached epidemic proportions on a worldwide scale. Developed as a sedative for pain relief, synthetic opioids cause the depression of the respiratory system and psychomotor impairment. Acute administrations of opioids can result in overdose and death. Besides, when opioids are ingested, they break down into metabolites—often other opioids—that end up in wastewater. Plasmonic material such as plasmonic NPs (silver or gold especially) are highly relevant materials because they have very interesting plasmonic properties when the light is interacting with those materials. Indeed, the localized surface plasmon (LSP) is a collective oscillation of the electrons confined inside metallic nanoparticles (NPs) or nanostructures and induced by the interaction with light. The LSP generation can have several effects on the local environment as the electrons are highly excited. It can induce local increase of the electromagnetic field (enhanced field) and of the temperature (thermoplasmonic effect) or generate the creation of hot electrons. As some catalytic reactions need a high temperature or an electron transfer to be initiated, both effects can be exploited to induce a LSP mediated catalytic reaction. As such, localized surface plasmon resonance (LSPR) mediated catalytic reactions can complement other alternative and non-traditional methods for accelerating catalytic reactions such as microwave heating, micellar catalysis.

Thus, the overall aim of the **Cataplasm** project is to prepare new nanocatalysts from plasmonic NPs and nanosurfaces to initiate and accelerate the reaction kinetics of N-dealkylation of opioids that will lead to the biological inactivation of the latter. Thus, to reach the objectives, the project will be conducted as follows:

First, (i) the student will

- synthesize porphyrin structures bearing anchoring group and prepare the corresponding organometallic structures
- prepare colloidal Au NPs
- combine colloidal Au NPs and metal porphyrins to form new nanocatalysts
- evaluate the catalytic properties of these nano-catalysts during their activation by plasmonic excitation through the N-dealkylation of model amines (such as tributylamine).

Second, (ii) he/she will

- prepare lithographied nanosurfaces functionalized by porphyrins.
- He/she will integrate those lithographied substrates into a microfluidic cell. Thus, He/she will study the irradiation of the solution to perform the N-dealkylation reaction and the reaction will be monitored directly inside the cell using Surface Enhanced Raman Spectroscopy (SERS) to detect, at very low concentration, the transformation of the N-alkylated amines around the nanosurfaces and the potential modification of the metal porphyrins.

Skills: The candidate should hold a master degree (or engineer school diploma) in chemistry. He/she must have a background and practice of organic and/or coordination chemistry including purification and classical characterization methods (chromatography, NMR, GC, Mass…). Interest and/or experience in catalysis, nanoparticles synthesis and physical chemistry would be beneficial. A good knowledge of English is recommended.

Context:
The project is part of an interdisciplinary collaboration between two teams: one in Ceisam laboratory at Nantes University and one with IMMM laboratory at the Mans University. The recruited person will be located at the Ceisam laboratory and will have to travel to the IMMM laboratory. The research will be supervised by Clémence Queffélec and Yann Pellegrin (Ceisam) and Marc Lamy de la Chapelle (IMMM). Our US collaborator (Pr. A. Knight, Florida Institute of Technology) will actively participate to the project and internships in his laboratory will be realised.

Contact:
To apply, thanks to send a résumé and a cover letter to
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- The recruited person may realize experiments at the IMMM lab.
- The recruited person may have to move to different sites for meetings / congresses. This will be financed by an IEA project coordinated by C. Queffélec.

Grant: EUR Lumomat (50%) and Doctoral contract of Nantes University (50%)

Salary : Between 1700 – 1800 euros

Starting date: 01/10/2022