3.5-year PhD studentship

Project title: Tracking the photochemistry fingerprint in plasmonic nanostructures

Supervisors: Professor David Richards

Deadline: 1st August 2022

Description of the position:

We seek a motivated student to join our international and diverse team at King's College London.

Chemical transformations lie at the heart of pharmaceutical and advanced materials development and are key to improving the environment through greenhouse gas reduction and pollutant decontamination. But our reliance on the chemical industry comes at a price of energy consumption and use of rare materials. Energy efficiency, sustainability and flexibility are challenges that need to be solved now to reach the UK goal of future environmental sustainability and carbon net-zero by 2050. In this context, photonics, one of the most energy-efficient enabling technologies, may provide new solutions to control and manipulate chemical processes efficiently with light and partly replace high-cost materials conventionally used to catalyse chemical reactions.

This project aims to explore and gain an insight into chemical processes at the interface with plasmonic nanostructures by tracking the fingerprint of molecular species using the optical spectroscopic technique of Raman scattering and applying a deep-learning framework.

When light interacts with plasmonic nanostructures, it can excite collective oscillations of electrons—surface plasmons. The surface plasmons can decay creating energetic (hot) carriers. The hot carriers in turn can be used to drive chemical reactions when they interact with molecules. These processes at the interface of plasmonics and molecular physics are yet to be well understood and explored. Raman scattering, involving the inelastic scattering of light by molecular vibrations, provides a spectroscopic fingerprint of molecular species. The Raman process can be enhanced by many orders of magnitude by the large electric field enhancements that molecules experience in the near-field of localised surface plasmons (the SERS effect), at which nanoscopic locations plasmon-induced photocatalysis is expected to be most efficient, while application of deep-learning techniques further enables high-quality reconstruction from noisy input data to gain new molecular insight.

As part of the PhD work, the candidate will have an opportunity to develop and apply a Raman spectroscopy experimental set-up for measurement of photochemistry on plasmonic nanostructures, to fabricate plasmonic materials, characterise them using a range of optical techniques and gain an insight using Raman spectroscopy of plasmon-mediated photochemical reactions. The candidate will gain experience in the application of machine learning techniques, employing a deep-learning framework recently developed at King's for Raman spectroscopic imaging datasets, and will be introduced to a number of self-assembly nanofabrication techniques, microscopy and spectroscopy. These studies will be supported by numerical simulations via finite-element methods, using software packages such as Comsol Multiphysics.

The successful candidate will be part of an exciting collaboration between physicists and chemists at King's College London, Imperial College London and the UK Catalysis Hub, as well as our industry partners.

Find more information by visiting https://www.kcl.ac.uk/research/photonics-nanotechnology or contacting Prof. David Richards directly.

Project funding:

Eligibility:

Candidate Requirements:

Prospective candidates will be judged according to how well they meet the following criteria:

- A passion for research, and motivation.

- A desire to learn new skills; not being afraid to apply yourself to new problems.

- Creativity and a collaborative spirit; the ability to work in a team.

- The ability to clearly communicate your ideas to your colleagues and to people beyond our research group.

- The ability to analyse data and test hypotheses.

- Practical laboratory experience.

The following skills are desirable, but can be learned during your study:

- Knowledge of data presentation / plotting software.

- Programming skills (e.g. Matlab / Python).

- Experience in working in a collaborative research environment.

- Experience in nanofabrication.

- Experience in working with optics.

- Experience in chemistry.

Application Procedure: Applications can be made at King's Apply. For further information please visit the KCL website at How To Apply.