3.5-year PhD studentship

Project title: Controlling photochemistry with plasmonic heterostructures

Supervisors: Professor Anatoly Zayats

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 chemical processes at the interface with plasmonic nanostructures and develop improved photochemical processes for a range of environmental and technological challenges. In particular, the project will investigate photochemical reactions within plasmonic tunnel junctions and hetero-nanostructures.

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. Hot carriers, such as electrons with high energy above the Fermi level, excited by light in plasmonic nanostructures have a broad spectrum of energies. In contrast, hot-carriers injected into plasmonic material via electron tunnelling have energies which can controlled by electric bias. Therefore, tunnel junctions can be used to harvest hot electrons for controllable activation of highly-confined chemical reactions (Nature Nanotechnology 13, 159 (2018)). These processes at the interface of plasmonics and molecular physics are yet to be well understood and explored.

As part of the PhD work, the candidate will have an opportunity to design and fabricate tunnel junctions with plasmonic materials, characterise them using a range of electronic and optical techniques and optimise to exploit hot-electrons for photochemical reactions. The candidate will be introduced to a number of self-assembly nanofabrication techniques, electron-beam lithography, 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. Anatoly Zayats 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.
- Experience in electronics.

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