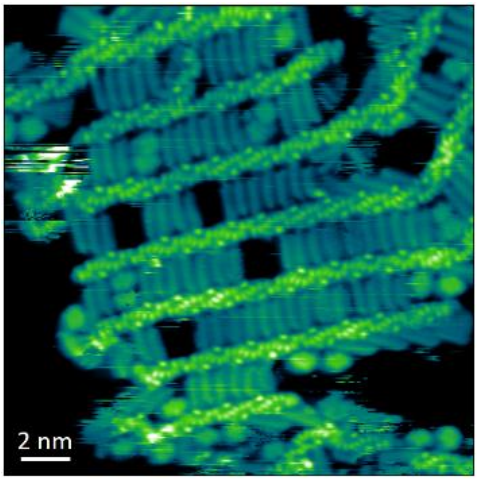
UNIVERSITY OF BIRMINGHAM

PhD project: Visualising Molecular Doping in Conjugated Polymers

A fully funded 3.5 years PhD position in the field of experimental nanoscience at surfaces and molecular imaging of conjugated polymers is available in the group of Prof. Giovanni Costantini at the University of Birmingham.

About the research: Conjugated polymers have become promising options as active materials for the next generation of energy conversion and (opto)electronic devices. To enhance the performance of these materials, molecular doping is a crucial process. This involves introducing small molecule "impurities" into the polymer matrix to increase the charge carrier density and modify the energy levels, thereby influencing its (opto)electronic properties. However, there is still limited understanding of the molecular doping mechanism. Fundamental questions remain mostly unanswered about the impact of doping on charge transport, the dopant miscibility and the dopant's positioning within the polymer host. Developing a molecular-scale picture of the doping mechanism is therefore of paramount importance for further progress and design of novel and efficient materials.



About the project: The Costantini Lab has recently demonstrated that a combination of scanning tunnelling microscopy (STM) and electrospray deposition (ESD) can be used to deposit intact conjugated polymers in ultrahigh vacuum (UHV) and to acquire sub-molecular resolved images, revealing their composition and structure at a level that is impossible with any other present analytical technique (e.g. *Sci. Adv.*, 2018; *Adv. Mater.*, 2020; *JACS*, 2021; *ACS Nano*, 2022; *Adv. Funct. Mater.*, 2023). In this project, the ESD-STM technique will be applied to study the interaction of small molecule dopants with conjugated polymers at the sub-nm scale. The aim is to establish the exact location, conformation, and interaction between dopants and host polymers as well as the extent of disruption to the polymer microstructure caused by doping. Scanning tunnelling spectroscopy (STS) will further be used to measure the local electronic structure of dopant-polymer complexes and to correlate this with their structural characteristics. Since this type of information cannot be achieved with any other present analytical technique, this project has the potential to deliver pioneering results of high fundamental and applied impact.

What we offer: The successful candidate will have access to a unique ESD-STM equipment to perform world-leading research. They will learn how to operate state-of-the-art sophisticated experimental setups working closely with senior researchers and experts in the field. They will be fully embedded into the highly collaborative and interdisciplinary research environment of the Costantini Lab. Their work will be firmly rooted in experimental nanoscience at surfaces, but will ultimately be directly applied in the design and development of new and efficient polymer-dopants systems. The project will be in collaboration with world leading synthetic groups at the University of Cambridge (UK), University of Oxford (UK), Stanford University (US), Peking University (China), University of Illinois Urbana-Champaign (US) and Georgia Tech (US).

Who we are looking for: Motivated students are welcome from various backgrounds, including physics, chemistry, engineering, and material science. However, we are particularly interested in applications from students with a strong preference for hands-on experimental work, not shy of operating, optimising (and sometimes repairing) complex experimental instruments involving mechanical, electronic and vacuum technology and know-how. A strong drive and curiosity for understanding the deep origins of physical and chemical processes and phenomena is essential. Applicants with previous experience in scanning probe microscopy and/or surface science are particularly welcome.

Funding for this position is open to **UK and international applicants** and the 3.5 years studentship will **start as soon as possible** from January 2024.

Enquiries and informal applications should include a C.V. and be addressed as soon as possible to Prof. Giovanni Costantini (g.costantini@bham.ac.uk).