SENTINEL

European Training Network in Single-Entity NanoElectrochemistry

2 early stage researcher opportunities available based at the

University of Warwick

Electrochemistry Group

Project Descriptions

ESR10: Advanced Nanoscale Electrochemical Imaging: Applications from Electrocatalysis to Living Cells

This post will be co-supervised by the Centre for Electrochemical Sciences at Ruhr-University Bochum.

Objectives: This project will advance electrochemical and functional imaging by creating a novel *lab-on-a-tip* technique (a scanned electrochemical probe microscopy tip with up to 4 individually addressable channels) to enable in situ, local and time-resolved chemical analyses at surfaces and interfaces. Applications will cover a wide range of single-entity nanolelectrochemistry applications from active sites on complex surfaces to single catalytic nanoparticles to single living cells.

Expected Results: This project will provide new capability in nanoscale electrochemistry and lead to a step change in understanding of how electrode surfaces, single catalytic nanoparticles and single cells operate. The work on electrocatalysis will focus on topical reactions and the cellular measurements will examine local cell properties in order to understand cell function in normal and diseased states. An important aspect of this project is that electrochemical images will be correlated with co-located complementary microscopy to reveal structure-function at the nanoscale. The importance of this new approach in electrochemistry is outlined in a recent Perspective from the Warwick group in *J. Am. Chem. Soc*. DOI: 10.1021/jacs.8b09828.

Planned Secondments:

- Ruhr-University Bochum - assessing electrocatalysts. The ESR will be exposed to the chemical analysis of single nanoparticles and will be trained on electrocatalytic measurement at the single nanoparticle level, with applications to fuel cells.
- Indiana University – scanning ion conductance microscopy. The ESR will have the opportunity to learn about scanning ion conductance microscopy (SICM) methods, which complement those available at Warwick.
- ETH Zurich – functional fluidic probes. This secondment will embrace functional SICM and FluidFM technology. The ESR will learn about local liquid dispensing and stimulation of surfaces and interfaces, including living cells.

ESR11: Electrochemical Nanoprobes for Single-Entity Analysis

This post will be co-supervised by Le laboratoire Interfaces Traitements Organisation et DYnamique des Systèmes (ITODYS) at the University of Paris Diderot.

Objectives: Functional nanoprobes will be developed to analyse single entities (from single molecules to single particles)on surfaces and in solution. These probes will be coupled with advanced methods of electrochemical analysis implemented at the nanoscale, such as electrochemical impedance spectroscopy (EIS) and advanced voltammetry techniques. Finite element method modelling combined with microscopy characterisation will be used to provide a deep understanding of how single entities interact with electrochemical nanoprobes.

Expected Results: This project will lead to a step change in capability for studying and understanding electrochemical processes at the ultimate single-entity level. Applications are wide, from understanding electroactive materials for energy technologies to biosensing. Development of smart electrochemical devices for single molecule detection in solution and within living cells will create new opportunities for nanoscale diagnostics.

Planned Secondments:

- University of Paris Diderot - hyphenation of electrochemical imaging with optical tomography. The ESR will learn to couple high-resolution optical microscopies to nanoelectrochemical techniques, providing in operando complementary visualisation of single electrocatalytic nanoparticles.
- University of Utah – modelling of nanoscale electrochemistry. The ESR will learn about COMSOL modelling and random walk simulations. There will also be the opportunity to use nanopore-based methods of single molecule/particle detection.
- Bio-Logic Science Instruments. The ESR will have the opportunity to translate knowledge to Bio-Logic and gain information on EIS to be implemented on the Warwick imaging platform.

About the Employer

The University of Warwick is one of the top universities in the UK, ranked 7th out of more than120 institutions in the UK Research Excellence Framework (REF2014), and 29th in QS World University Table in 2015. The Department of Chemistry ranked 6th in the whole of the UK in the latest UK research assessment (REF2014) alongside Imperial College London and UCL, with 98% of its research classified as *world-leading* or *internationally excellent*. The Department has an outstanding track record of attracting national and international staff, graduate students and funding, as well as hosting a substantial portfolio of industrial collaborations with more than 30 companies.

This post will be based within a world-leading Electrochemistry Group of 35 members from more than 12 nations. The Group has 7 purpose designed laboratories with an impressive array of world-leading and unique instrumentation for frontier research including 9 state-of-the-art instruments for high resolution electrochemical imaging (e.g., SECCM, SECM, IC-SECM and SICM) and facilities required for pipette (probe) fabrication and characterisation (AFM, confocal, optical microscopy). There are COMSOL licenses for modelling and networked PCs for analysis. There will be impressive equipment available for this project that is free at the point of access. Various electrochemical workstations, x-ray fluorescence, ICP, and other analytical techniques are all available for use. Cell culture facilities are in a neighbouring laboratory and accessible.

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