Seminar
Department of Chemical and Biomolecular Engineering
Hong Kong University of Science and Technology

Nanoscale Flux Imaging: New Perspectives on Electrode Processes,
Complex Interfaces and Living
By

Patrick Unwin
University of Warwick, UK
www.warwick.ac.uk/electrochemistry

Abstract

Interfacial physicochemical processes embrace some of the most important contemporary scientific and technological challenges, including, for example: energy conversion and utilisation, via improved surface catalysts; the development of new generations of molecular sensors, with improved sensitivity and selectivity; and understanding multiscale natural processes around us, from cell function to geochemistry. Although the structure of surfaces and interfaces is often complex and heterogeneous (and can be measured as such), most interfacial chemical flux processes have been investigated by space (and time-) averaged methods, which may obscure key features or even lead to the wrong interpretation or microscopic model. I will set out some major challenges in electrochemistry and interfacial science and introduce new approaches for probing and analysing interfacial chemical fluxes. The philosophy is general and the analysis is widely applicable in electrochemistry, materials science and – increasingly - the physical/life sciences interface. The focus is on electrochemical scanned probe microscopy techniques, where recent developments now allow (electro)chemical fluxes to be probed and manipulated with unprecedented resolution, opening up new vistas on interfaces. I will introduce the Warwick Electrochemical – Scanned Probe Microscopy Platform (WEC-SPM), a suite of multifunctional techniques that are providing major new insights into a wide variety of processes, from the functioning of new electrode materials, such as nanoparticles [1], nanotubes [2], graphite/graphene [3] and complex electrodes at the nanoscale [4], to the dissolution of crystals and biominerals [5], cellular processes [6], ion flux and charge mapping [7], and as devices for patterning/printing [8] and micro/nanofluidics [9]. Looking forward, the field of electrochemical imaging is at an exciting nexus: the concept and methods of interfacial flux imaging are expected to gain significant momentum in materials science and the life sciences, where structure-activity issues are paramount. Emerging challenges to push electrochemical imaging further, including the detection of increasingly small (fA) current signals, high speed imaging/fast data acquisition, and the analysis of large datasets will be outlined.

Brief Bio:
Professor Patrick Unwin is a Full Professor of Chemistry (since 1998) at the University of Warwick (UK) and Director of the Warwick Centre for Doctoral Training in Analytical Science. He is well-known for the development and application of novel electrochemical techniques, especially electrochemical imaging methods. He established the Warwick Electrochemistry & Interfaces Group (www.warwick.ac.uk/electrochemistry) in 1992, which has built an excellent international scientific reputation and has developed outstanding facilities for research in electrochemistry and interfacial science. More than 50 PhD students and > 25 postdoctoral researchers, including 7 Marie Curie European Research Fellows, have graduated from the Group. The Group currently comprises ca. 40 postdoctoral Fellows, PhD students and Masters students supported by a range of funding and working on a diversity of projects in a multidisciplinary environment. Unwin is a graduate of Liverpool University (BSc, top 1st in 1985) and obtained his DPhil with Richard Compton at the University of Oxford (1989), where he was Dee Graduate Scholar. He held positions as Junior Research Fellow in Physical Sciences at Balliol College, University of Oxford (1988-90) and SERC/NATO Fellow with Allen Bard at the University of Texas at Austin, USA (1990-91), before moving to Warwick. Unwin has published ca. 300 papers in leading journals, is the editor of 3 books, one of 4 international editors of Journal of Electroanalytical Chemistry (2011-), and a member of the international editorial boards of several journals including the ACS journal Langmuir (2014-) and Electrochemistry Communications (1999-). He has won many prizes for his research including the Tilden Prize (2012), Geoffrey Barker Medal (2010), Corday-Morgan Medal and Prize (2001) and Marlow Medal and Prize (1997), all from the Royal Society of Chemistry. He gave the 2013 Lavoisier Lectures, Université Paris Diderot-Paris 7, France, 2013 (first invitee from outside the USA) and is a European Research Council Advanced Investigator (2010-15) (first award in electrochemistry).

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