Atomic structure and applications of supported, size-selected metal nanoclusters and prospects for super-abundant production

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The controlled deposition of size-selected nanoclusters (nanoparticles), assembled from atoms in the gas phase, is a novel (and economically efficient) route to the fabrication of surface features of size <10 nm [1]. However theoretical treatments of the atomic structure of clusters far outstrip direct experimental measurements. In this talk I will focus on the creation and imaging of stable, monodispersed, monometallic and bimetallic [2] cluster arrays which represent new model systems for precision catalysis [3] and can also be used to trap and orientate individual protein molecules [4]. The atomic structure of the deposited clusters is revealed [5] by aberration-corrected scanning transmission electron microscopy (STEM) in the high-angle annular dark field (HAADF) regime with a spatial resolution of 0.1 nm; measuring the intensity of the incoherent scattering from individual atomic columns enables us to "count" atoms [6] and thus obtain 3D information rather than just 2D projections. Results include mass spectrometry of passivated Au clusters [7], atomic imaging of Au adatom dynamics on the surface of Au_{923} magic-number nanoclusters [8], the purposeful transformation of size-selected clusters under the electron beam to obtain the ground state structure [9] and first atomic imaging results for small Au clusters, notably Au_{55} and Au_{20} [10,11]. Finally I will also propose a new kind of cluster beam source with the potential to allow super-abundant generation of such size-selected nanoclusters.

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Biography

Professor Richard E Palmer is Professor of Experimental Physics at the University of Birmingham and Head of the Nanoscale Physics Research Laboratory. His research interests include atomic clusters, biochips, atomic manipulation and nanofabrication. He obtained his first degree (1983) and PhD (1986) at Cambridge University, where he held 1851, Clare College and Royal Society Research Fellowships. He has held visiting positions at Cornell, Oxford and Harvard Universities and the Technical University of Denmark. He has been elected to Honorary Professorships at the University of Wales, Swansea, Harbin Institute of Technology, China and the Petronas University of Technology, Malaysia. He was awarded the 1996 Charles Vernon Boys Medal of the Institute of Physics (IoP) and gave the Mott Prize Lecture in 1997 and IoP Ireland Lectures in 2006. He was founding Chair of the IoP's Nanoscale Physics and Technology group. He was awarded an Honorary Doctoral Degree (dr. h.c.) by Hasselt University, Belgium in 2010 *"for his pioneering work in nanoscale physics and his contributions to bridging the gap between nanoscience and nanotechnology"*. He is author of >300 publications and 18 families of patent applications. He has given > 200 invited lectures and his work has featured in >100 media articles/programs. He is a member of seven editorial boards including Nano Energy, Small and ACS Nano and book series editor of the Elsevier Series on Frontiers of Nanoscience. He was elected Fellow of the Royal Society of Chemistry in 2012.