Seminar

Organising atoms: from atomic manipulation to size-selected atomic clusters

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地点： 理科五号楼607会议室

Abstract

Atomic manipulation is the extreme limit of nanotechnology. I will discuss the manipulation of polyatomic molecules – notably chlorobenzene (C_6H_5Cl or PhCl) – anchored to a silicon surface, with a focus on new mechanisms for single molecular manipulation via electron injection. Such mechanisms may (eventually) be relevant to chip-scale molecular manufacturing. I will report site-specific non-local atomic manipulation (leading to molecular desorption) of PhCl: effectively this is 'remote control' of molecular manipulation. This non-local electron attachment mechanism is also thermally activated (barrier 0.4 eV) and suppressed by the proximity of the STM tip itself, both results explicable in terms of electron-driven excitation to an intermediate physisorbed state. Moreover we find that C-Cl bond *dissociation* in the molecule is also thermally activated, with an energy barrier of 0.8 ± 0.2 eV, which we correlate *thermal* excitation to the physisorbed (precursor) state of the molecule, where electron attachment occurs.

The controlled deposition of size-selected nanoclusters, assembled from atoms in the gas phase, is a novel route to the fabrication of surface features of size <10 nm. Monodispersed, monometallic and bimetallic cluster arrays represent new model catalysts and a route to protein biochips. Theoretical treatments of the atomic structure of clusters far outstrip direct experimental measurements. Here the atomic structure of the deposited clusters is revealed experimentally by aberration-corrected scanning transmission electron microscopy (STEM) in the high-angle annular dark field (HAADF) regime; we can “count” atoms and thus obtain 3D information rather than just 2D projections. Results include mass spectrometry of passivated Au clusters, atomic imaging of Au adatom dynamics on the surface of Au_{923} magic-number nanoclusters, first atomic imaging of small Au clusters, notably Au_{55} and Au_{20} and a method to explore the potential energy landscape of clusters, by the purposeful transformation of clusters under the e-beam to more stable configurations . We hope these new data will help to enhance theoretical treatments of both cluster structure and dynamics, e.g., via refinement of empirical potentials.

Finally, a new kind of cluster beam source, designed to allow super-abundant generation of size-selected nanoclusters including binary systems, will be proposed.

About the Speaker

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. He has been elected to Honorary Professorships at the University of Wales, Swansea and Harbin Institute of Technology, China. 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, and his work has led to the formation of a series of spin-out companies. 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 editor of the Elsevier Series on Frontiers of Nanoscience. In 2012 he was elected Fellow of the Royal Society of Chemistry and won a senior EPSRC Fellowship. He was recently (2013) awarded the Senior Prize and John Yarwood Memorial Medal of the British Vacuum Council.