PhD Position

MAPPING THE INTERNAL WORKINGS OF A SINGLE MOLECULE

The ultimate building blocks of matter are atoms and molecules. If we can control these we can truly build from the bottom up. In 1986 the Nobel prize was won for the invention of a microscope that can image individual atoms and molecules, the scanning tunnelling microscope (STM). And in 1989 that microscope was used to assemble a man-made structure atom-by-atom with atomic precision; a 35 Xenon atom advert for IBM. But molecules are quantum objects and quantum mechanics is probabilistic. To get an accurate understanding of how the STM controls and manipulation molecule requires not only exquisite experimental apparatus but extensive data.

Details of the Project

This project will be based on two STM machines, one at room temperature and the other at low temperature (see fig 1). It will make extensive use of existing and new control software to allow for (unique to Bath) automated and multiple repeat experiments [1]. For example, we will fully explore the internal workings of bi-phenyl on a silicon surface. This work was originally conducted with hundreds of measurement [2], here will aim to record many hundreds of thousands of results. This benchmark experiment will allow a broad and accurate picture of how the molecules actually reacts to the excitation induced by the STM.

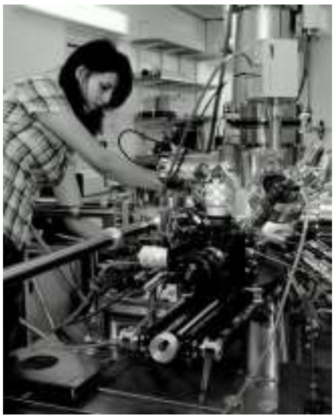

Figure 1 Low temperature STM at Bath

For the second part of this project the student will choose a target molecule that is of interest to the EBID (electron beam induced deposition) community. EBID is seen as a possible successor to conventional photo-lithography for the continuing miniaturization of computer chips. A gas of molecules that contain, for example Platinum (Pt) atoms, are exposed to an electron beam. Where this beam strikes a surface the gas molecules react and deposit Pt atoms. As the beam is traced across the surface so a nanowire of Pt is drawn. But it is surprising how little is known about the electron/molecule interaction that lies at the heart of EBID. We will apply our experimental techniques to uncover the inner workings of an EBID process. Instead of an electron beam we will use the electrons that tunnel from the tip of the STM, and instead of a gas of molecules we adsorb molecules on to a surface. Thus we will create an ideal EBID system that will allow us to examine it under “laboratory” conditions.

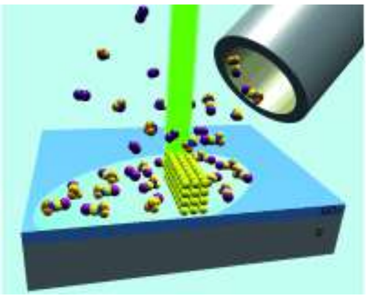

Figure 2 Schematic of EBID

[1] Sakulsermsuk, S., Sloan, P. A. et al., J. Phys-Cond Mat, 2010, **22**, 084002. [2] M. Lastapis, et al., Science, 2005, **308**, 1000.

Applications: Applicants should have a background in the physical sciences and have or expect to gain a First or Upper Second Class UK Honours degree, or the equivalent from an overseas University. Possible funding sources include the Doctoral Training Account (for UK applicants) or Faculty/University studentships and scholarships. Applications from self-funded students are always welcome.

Contact Dr Peter Sloan (P.Sloan@bath.ac.uk) for further information on the project.
Website http://blogs.bath.ac.uk/atomic-manipulation/