NANOWIRES AND NANOGAPS FOR MOLECULAR ELECTRONICS

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We present our characterisation results to date for Au and Au/Pd nanowires of cross-sectional dimensions 200nm down to 20nm, measuring resistivity dependence on wire width as well as mean time to failure at specific current densities with the goal of more completely characterising the physical and electrical properties of nanowires. A conducting atomic force microscope with a diamond-coated cantilever is used to measure the potential on the surface of the nanowire device, and a potential map of the surface shows most of the potential dropping across the nanowire, indicating it is the main resistive component of the circuit. Finer resolution microscopy is expected to resolve the surface potential in the μV range, allowing the observation of potential differences across the individual grain boundaries within the nanowire. Through careful control of the current stressing conditions of the nanowires, the electromigration process can be used to create break-junctions of a controlled gap size, enabling their use in molecular devices. After failure, we also monitor the resistance across the break-junction to assess stability. Mean time to failure and average failure current density are recorded for wires of different widths. The resultant nanogaps open up the possibility of making novel molecular devices, including molecular transistors, facilitated by the introduction of 1,4-benzene dithiol molecules, other alkanethiols, and porphyrins in various configurations. We propose to investigate molecular devices using functionalised molecules under two scenarios: i) using the resultant nanogap break-junction leads as the connecting electrodes, and ii) using DNA-templated structures as the connecting electrodes. Future work will focus on i) making nanogaps through failure by electromigration a more robust process, and ii) creating more reliable contacts between molecules and electrodes with the aim of reducing contact resistance.

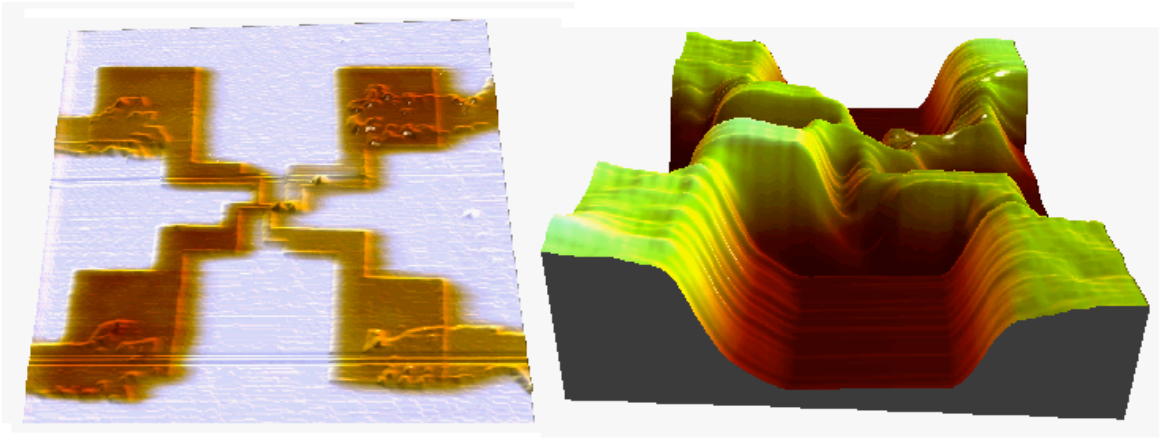

Figure 1. Topography and potential map of an AuPd nanowire with width = 20 nm

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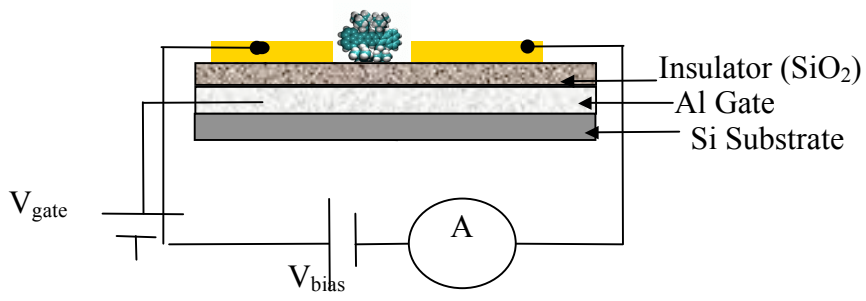

Figure 2. Formation of break-junctions through failure by electromigration and subsequent insertion of molecules in a nanogap to form a molecular transistor