MAR06-2005-001131

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Mechanically-Adjustable and Electrically-Gated Single-Molecule Transistors[1]

ALEXANDRE CHAMPAGNE[2], Cornell University

We describe the fabrication and characterization of single-molecule transistors whose properties can be tuned in two independent ways to achieve systematic measurements of electron transport. The spacing between the source and drain electrodes can be adjusted with better than 1 pm stability using the mechanical breakjunction technique – the electrodes are freely suspended above a flexible substrate, and their spacing can be varied by bending the substrate. In the same devices, we are also able to apply a gate voltage to the molecule. This is done by employing lithographic techniques to suspend the breakjunction only 40 nm above the substrate surface and using the substrate as an electrostatic back gate. With the independent in-situ variations provided by these two experimental "knobs", we are able to achieve a more detailed characterization of electron transport through the molecule than is possible with either technique separately. To demonstrate the device capabilities, we have studied transport through single C_{60} molecules at low temperature. We observe Coulomb blockaded transport and can resolve discrete energy levels of the molecule. We are able to mechanically tune the spacing between the electrodes (over a range of 5 Å) to modulate the lead-molecule coupling, and we can electrostatically tune the energy levels on the molecule by up to 160 meV using the gate electrode. We will also present data of Kondo transport in single $[Co(tpy\text{-}SH)_2]^{2+}$ molecules. We are able to vary the strength of the Kondo resonance in these devices by changing the spacing between the source and drain electrodes.

[1]This work was conducted with J. J. Parks, A. N. Pasupathy, and D. C. Ralph.
[2]Current address: Physics Dept., California Institute of Technology