Using Light to Control
Single Molecule Transistors at Low Temperatures

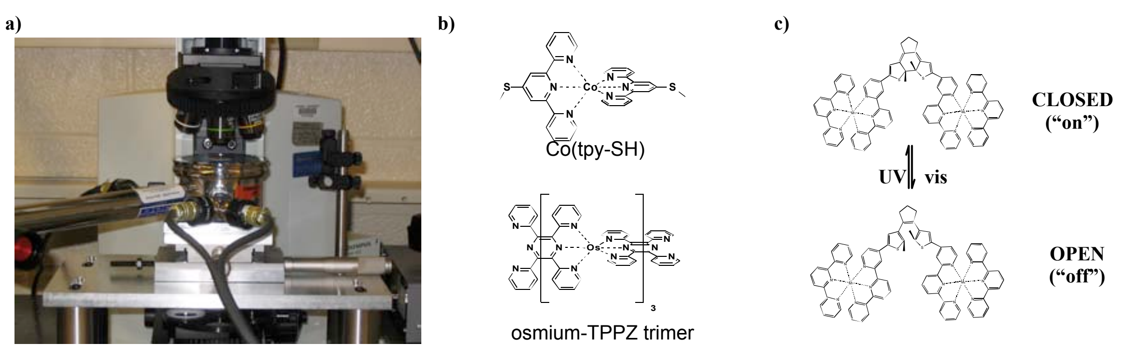
NSF NIRT Grant 0403806

PIs: **H. D. Abruña**,[1] **G. W. Coates,**[1] **P. L. McEuen,**[1] **D. C. Ralph,**[1] **J. P. Sethna,**[1] **M. A. Ratner**[2]

[1]Cornell University, and [2]Northwestern University

The process of shrinking silicon transistors to smaller and smaller sizes will soon be limited by fundamental physics barriers. In response to these barriers, scientists and engineers are trying to understand the basic physical principles governing current flow in different types of nanoscale devices. Recently, our group has helped lead the development of low-temperature field-effect transistors in which the active element is a single molecule, a device known as a single molecule transistor [SMT]. This was accomplished through electromigration of nanoscale gold wires into "breakjunctions"with gaps on the order of a few nanometers [1-3]. In our present work, we are trying to find out if light of a specific frequency can be used to alter and control the flow of current through SMTs. This is fundamental research that will lead to a better understanding of the mechanisms by which single-molecule devices operate.

There are two classes of molecules we have synthesized for our experiments, which make use of laser light focused by an optical microscope onto a single-molecule transistor inside a low-temperature cryostat (see Figure 1a). The first class consists of molecules (Figure 1b) which we can excite with our laser so that, if placed in an SMT, photoexcited electrons from a single molecule will contribute directly to the current flow. The second class of molecules (Figure 1c) should act as "molecular switches," which means that the molecules change structure upon application of light of different frequencies to toggle between a high resistance state and a low resistance state in an SMT. All experiments take place at low temperatures (around 3 K) in order to minimize extraneous thermal effects.



[1] H. Park, *et al. Nature* **407**, 57 (2000).
[2] J. Park, *et al. Nature* **417**, 722 (2002).
[3] W. Liang, *et al. Nature* **417**, 725 (2002).