Mechanically-Adjustable and Electrically-Gated Single-Molecule Transistors

ALEXANDRE CHAMPAGNE, ABHAY PASUPATHY, JOSHUA PARKS, DANIEL RALPH, Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, NY — We describe the experimental characterization of molecular transistors that can be both mechanically adjusted and electrostatically gated. We control the source-drain spacing with better than 1 pm stability by making use of a mechanically-controlled breakjunction geometry. In addition, by using silicon substrates, we can employ standard lithographic techniques to suspend our breakjunctions only 40 nm above the substrate surface, enabling the use of the substrate as an electrostatic back-gate. We present data for single-electron-transistor C$_{60}$ devices which show that we can simultaneously tune the source-drain electrodes spacing by 5 Å mechanically and shift the molecules energy levels by 160 meV electrostatically. With the independent in-situ variations provided by these two experimental “knobs”, we are able to achieve a much more detailed characterization of electron transport through the molecule than is possible with either technique separately. We also present initial results for gated devices in which a single carbon nanotube is stretched axially.