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Electrical and Spectroscopic Characterization of Metal-Molecule-Metal Junctions[1]

THERESA MAYER, Penn Sate University

Considerable attention has been devoted to developing an understanding of the mechanisms that dominate electrical transport in metal-molecule-metal junctions comprised of single and small ensembles of molecules. In this talk, we will present an overview of recent research on the electrical and spectroscopic characterization of molecular junctions inserted along the length of sub-40-nm diameter Au and Pd metal nanowires (i.e., in-wire junctions) fabricated by template-directed synthesis. In particular, we will show results that investigate the relationship between the temperature dependent (10 – 300 K) current-voltage (I-V) characteristics and the vibrational spectra measured by inelastic electron tunneling (IET) spectroscopy for candidate molecular wires and bistable switching molecules. The two types of molecular wire junctions that were studied incorporate a self assembled monolayer of dithiolated oligo(phenylene- ethynylene) (OPE) molecules or their -NO_2 derivatives. The I-V of these junctions are stable and reproducible between +/-1V. Temperature independent I-V are measured for both types of junctions, which is indicative of coherent tunneling transport. Moreover, strong vibrations associated with υ(18b) and υ(19a) ring modes were observed in both junctions. In contrast, measurements of molecular junctions that incorporate SAMs based on aniline derivatives show reproducible bistable switching with an on-off ratio of >10:1 at 1V. Differences are observed in the vibrational spectra that depend on the state of the junction.

[1]L. Cai [1], M. Cabassi [1], C. McGuiness [2], D. Allara [2], A. Flatt [3], and J. Tour [3], [1] Departments of Electrical Engineering [2] Chemistry, Penn State University, University Park, PA, and [3] Chemistry, Rice University, Houston, TX