Molecular Orbitals Gating for a Single Long, Rigid, Planar Molecular Wire

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We have reported that carbon-bridged oligo(phenylenevinylene)s (**COPV*n***) serve as effective molecular wires as demonstrated by photoinduced electron transfer because of their rigid structures to achieve effective π-conjugation.[1-2] In this presentation, we demonstrate that resonant tunneling through molecular orbitals for **SAuSH** device, in which **COPV5(SH)$_2$** molecular wire (Figure 1) is one-side chemical bonded to electrodes. Due to improved nanogap electrodes of our electroless Au-plated (ELGP) nanogap Pt electrodes with the top radius of a few nm, we report that resonant tunneling is modulated by application of gate voltage. The initial structures of the source, drain, and two side gate electrodes of Ti/Pt were fabricated on a SiO_2/Si substrate via electron beam lithography (EBL) and lift-off processes. Electroless Au-plating was carried out to reduce the electrode gaps to ~3 nm (Figure 2), followed by the introduction of a **COPV5(SH)$_2$** molecule between the nanogap electrodes by immersing into a solution of **COPV5(SH)$_2$**. We then measured the current-voltage (*I*-*V*) characteristics at 9 K using a mechanical He-refrigerator-type prober station, and differential conductance is numerically calculated in Figure 3. Negative second d*I*/d*V* peak have been observed largely shifted by application of gate bias at -8 V (Figure 3, red lines). We suggest that the transport mechanism of this single molecular wire is resonant tunneling phenomena under the alignment of a molecular orbital with Fermi energy of a source or drain electrode.

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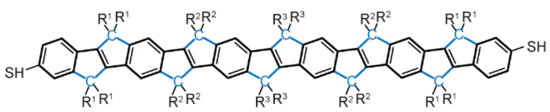

Figure 1: Structure of **COPV5(SH)$_2$**

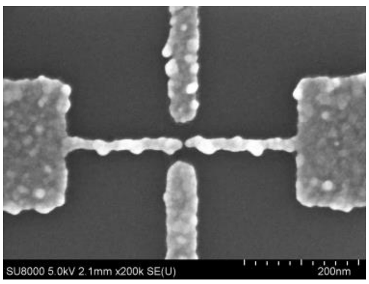

Figure 2: Typical SEM image for electrodes

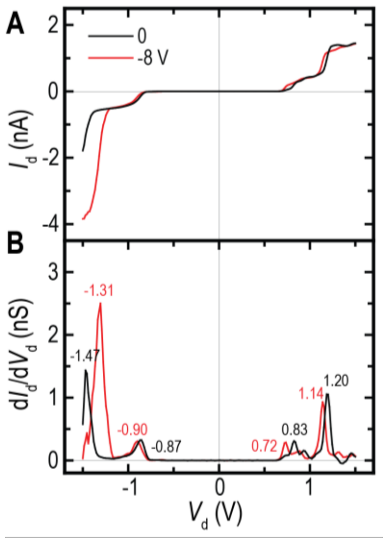

Figure 3: *I*-*V* characteristics under the application of gate voltage of 0 and -8V at 9 K