Space Charge Effects in Single Molecular Devices

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Abstract

Strong negative differential resistance (NDR) has been recently observed in π-conjugated oligo (phenyleneethynylene) single-molecular devices consisting of two parallel metal (Au) electrodes which are separated by a self-assembled monolayer having a thickness on the order of 2nm.[1] The sudden drop in current suggests that nonlinear feedback associated electron transport through intermediate molecular states may be responsible for the observed NDR. We propose that the transfer of electrons from the cathode to the anode takes place via nearest-neighbor hopping between two weakly coupled oligomer states. In such a case, the current is highest when the energies of the two states are coincident, and is suppressed when the voltage drop between them is sufficient to take them far out of resonance. The modification of the voltages within the junction due to accumulated space charge causes the states to become pinned. We show that this collective behavior enhances the abruptness of the NDR, and under appropriate circumstances leads to a triangularly shaped hysteresis loop in the current-voltage relation.

References

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Biography

David H. Dunlap is an associate professor of physics at the University of New Mexico. His research is theoretical, concerning charge transport in disordered materials, as applied to the operation of organic electronic devices.