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Measurement of the Conductance of Single Conjugated Molecules

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Electrical conduction through molecules depends critically on the delocalization of the molecular orbitals, and their weight on the metallic contacts. Thiolated conjugated organic molecules are therefore often considered as good candidates for molecular conductors. In such molecules the orbitals are delocalized throughout the molecular backbone, with substantial weight on the sulfur-metal bonds. However, their relatively small size, typically 1 nm, calls for innovative approaches to realize a functioning single molecule device. In this paper we report a new approach for contacting a single molecule and use it to study the effect of localizing groups within a conjugated molecule on the electrical conduction. Our method is based on synthesizing a dimer structure, consisting of two gold colloids connected by a di-thiolated short organic molecule, and electrostatically trapping it between two metal electrodes. We study the electrical conduction through three short organic molecules: A fully conjugated molecule, 4,4'-biphenyldithiol (BPD), 4,4'-biphenyletherdithiol (BPED) in which the conjugation is broken at the center by an oxygen atom, and 1,4-benzenedimethanethiol (BDMT), where the conjugation is broken near the contacts by a methylene group. We find that the oxygen in the BPED and the methylene groups in the BDMT suppress the electrical conduction relative to the BPD.