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Photocurrents and Photoemission in All-Carbon Molecular Electronic Junctions

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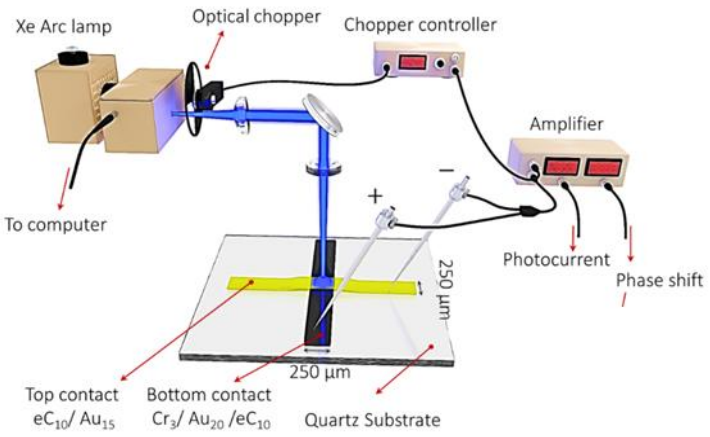
Abstract:

Molecular electronic junctions consisting of 2-10 nm thick conjugated oligomers between conducting carbon contacts show distinct electronic behaviors from conventional semiconductors or thicker organic films, and often involve distinct physical principles. Interactions with light provide a means to probe internal device energy levels in order to better understand the charge transport mechanisms and provide a basis for rational design of unusual electronic devices. Illumination of molecular junctions with UV-Vis light through partially transparent electrodes produces stable photocurrents with zero applied bias, or photovoltages at open circuit. If the molecules do not absorb light, internal photoemission underlies the transport mechanism. [1-2] For absorbing molecules, the sign of the photocurrent indicates which orbitals are nearest in energy to the Fermi level, and the photocurrent spectrum approximately tracks the in-situ absorption spectrum of the molecular layer inside the junction. [3] Analysis of the bias, thickness, and temperature dependence of the photocurrent under an applied bias reveal a distinct mechanism compared to the dark current, with near-resonant transport and inverse temperature dependence compared to typical activated transport mechanisms. Light emission from molecular junctions is also a useful probe of conduction mechanisms, and may involve both “hot electron” photoemission [4-5] and photons from bias-induced exciton formation. [6]



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