Charge transport in solid state molecular junctions

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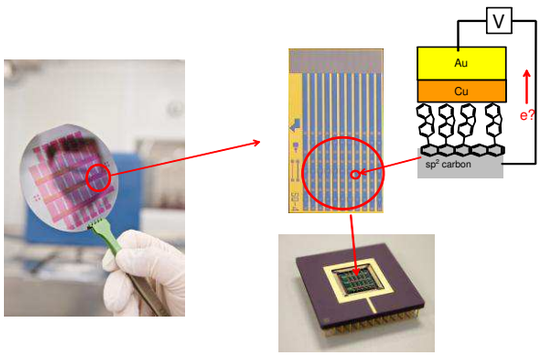
The term “molecular electronics” has evolved to currently refer to charge transport through circuits which contain molecules as active elements, with transport distances of typically less than 10 nm. Quantum mechanical tunneling and ballistic transport are possible in such devices, resulting in quite different behavior from that in traditional semiconductors or thicker films common in organic electronics. Our approach to the problem is based on a layer of molecules covalently bonded to a conducting graphitic carbon substrate and a metal or carbon top contact[1-4]. Transport in carbon/molecule/carbon molecular junctions is controlled by tunneling for distances < 5-8 nm, and by activated redox exchange for >13 nm films. Between these two extremes is a third mechanism which is enabled by the high electric fields in molecular devices. It is temperature independent, long range compared to tunneling, and exhibits an exponential dependence on the square root of the electric field. This mechanism likely involves ionization of orbitals in the molecules to yield conducting channels, analogous to field ionization of electrons into a vacuum from a conductor. Progress toward the central objective of rational design of molecular electronic circuits will be described, as will initial efforts toward commercial applications[5].



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