Tutorial
What Kind Of Monomolecular Electronics?

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Different ways are now explored for the design of a digital logic circuit with molecule(s). One, called Hybrid Molecular Electronic, is a direct descendent of the Aviram-Ratner molecular diode concept introduced in 1974. Another one, called Mono-Molecular Electronic, is inspired from the molecular circuit proposal of F.L. Carter in 1980 and a third one, also mono-molecular by principle, is a molecular extension of the concept of quantum computer introduced by R.P. Feynman in 1984. Each design is demanding chemistry, a specific technology, a specific architecture and in the future specific strategies to put it in production, if possible.

As a principle, in Hybrid Molecular Electronic, each device will be made by a single molecule (or in a molecular material version of the original Aviram-Ratner concept, by a macromolecule). Hybrid molecular electronic is not the subject of this M2e working group (see the Alternative Electronics Working Group).

As a starting point, monomolecular electronics supposed that a single and always the same molecule would perform the full computation. This put forwards many questions different from Hybrid Molecular Electronics. The first one is the problem of the resources available inside a molecule to perform computation. The second one is the problem of interconnects and more generally of exchanging orders and data with a given molecule (what is now called nano-communications). A third one is the precision required by the technology in order to use those intramolecular resources optimally.

The problem of resources will be illustrated by (1) the new circuit rules that must be applied to force a single molecule to have the shape and the function of an electronic circuit and (2) by the presentation of the Hamiltonian computer approach leading to intramolecular time circuit. (1) Can be called semi-classical monomolecular electronics and (2) hemi-quantum monomolecular electronics.

The problem of interconnects will be illustrating by discussing the relation between computer complexity and number of interconnects. For example, is an atomic metallic wire, one atom in section, the best interconnect to use optimally computing resources from inside a single molecule ?

The problem of the precision of the technology will be illustrated by showing how the contact conductance of a molecular wire is depending with a precision of about 0.05 nm of the position of the molecular wire on its atomic scale contact electrodes pointing out the need for an atomic scale technology.