Molecular Electronics with Novel Flexible NanoWires

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It is the end of miniaturization as we know it, we are reaching the intrinsic, atomic, limit for current materials and technologies. Yet, there is a growing demand for increasingly smaller devices which asks for circuits whose components are as small as possible. Molecular electronics has sparked great interest because the manufacture of electronic circuits with molecules might potentially entail a maximum reduction in size.

We have made a new class of nanowires that are not only flexible but highly efficient electron conductors. These new nanowires are molecules synthesized and characterized by the group of Aurelio Mateo-Alonso, an organic chemist from San Sebastian (Spain), and were studied in Barcelona (Spain) with an electron microscope that measured, one molecule at a time, their electrical properties. Manuel Melle-Franco, using applied computer modelling, complemented these studies in Aveiro. Several models had to be produced and were fundamental to rationalize the experimental findings in these new molecules, as their intrinsic flexibility made understanding their properties a formidable task.

Modelling allows studying virtually the folded and unfolded forms this flexible nanowire might adopt, Figure 1. Extended nanowires cannot conduct electricity, as the electrons are in localized areas of the molecules and cannot move over long distances. Conversely, in the folded nanowire, different sections of the molecule "touch" allowing for the electrons to jump from one section to the next opening a channel for electricity flow.

Technologically, each of these folded molecules may act as a tiny cable that transports electric currents in very small dimensions, showing high potential for nanoelectronic circuits. In addition, if the folding might be controlled or triggered externally, they might also function as electrical nanoswitches. More details can be found in "High conductance values in π-folded molecular junctions" in Nature Communications, 2017.

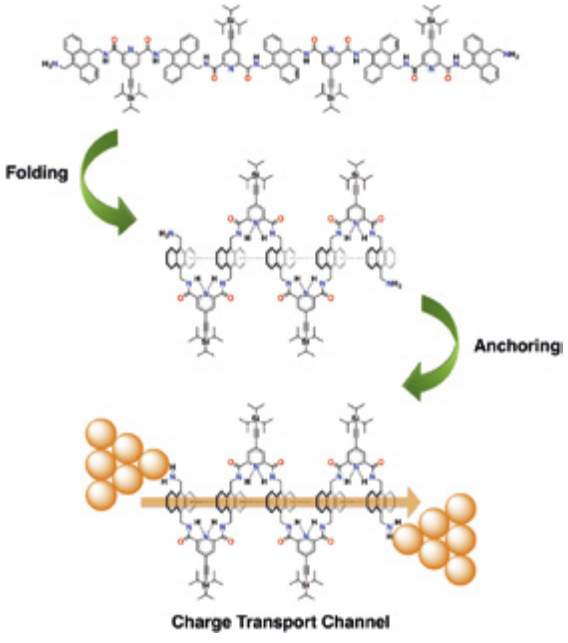

FIGURE 1
Folded molecular junctions. Schematic representation of the folding and anchoring processes needed to obtain folded molecular junctions that act as nanowires.