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A single molecule diode opens up a new era for sustainable and miniature electronics

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A newly synthesized molecule reveals exceptional electronic properties. The results of this study led by researchers from Université catholique de Louvain (Belgium) and from Stanford University California are published in *Nature Communications*.

In the domain of electronics, the continuous quest for miniaturisation is pushing us towards the creation of devices which are continuously becoming smaller and more efficient. However, silicon - the basic component for most of these devices which caused a true revolution in electronics - , begins to disclose its physical limits. The smaller the silicon system, the harder it gets to control its return. The point has been reached where scientists have started looking for alternative materials, better fit for the miniaturised formats.

One of the alternatives to provide an answer to this challenge, are the molecular electronics. Somewhere between chemistry, electronics and science of materials, this research domain aims at using molecules –more in particular organic molecules – with particular electronic characteristics. As such, one single molecule could represent an electronic component such as a transistor or a diode. Developed at the Université catholique de Louvain (UCL, Belgium), this new type of electronics requires the synthesis of new molecules or hybrid assemblies to new or improved properties.

In collaboration with the Stanford University of California, two UCL research teams managed to study and to understand the electronic characteristics of a newly synthesized molecule, composed of two forms of carbon: a fullerene (C60) and a nano-aggregate of diamond. This study, published in *Nature Communication*, reveals exceptional electronic properties for this molecule, given it conducts electrical power into one direction but not into the opposite sense. It behaves in other words as a diode, but at the scale of a molecule, with only a few nanometers. These measures, performed with the participation of Professor Sorin Melinte (ICTM, UCL) became possible thanks to an atomic manipulation technique which is practically the worldwide exclusive area of competence of the Stanford researchers. This is enabled by means of a scanning tunnelling microscope allowing to conduct electrical power through one single molecule.

After the discovery of the particularly promising electronic properties of this molecule, the teams of Professors Jean-Christophe Charlier (IMCN, UCL) and Sorin Melinte, modelled these properties in order to understand why electrical power was passing in one sense but not into the opposite sense of this molecule. Digital simulation techniques based on quantum mechanics, allowed understanding this phenomenon from a theoretical point of view. After being elaborated by Doctor Andres Botello-Mendez, responsible of FNRS-research, this modelling can be used as from now to predict the electronic behaviour of other molecules of this type.

The long-term perspectives of these discoveries not only provide new miniaturisation opportunities for future computers, tablets and other electronic devices, but also for " green " devices based on organic molecules.

More information: Jason C. Randel, Francis C. Niestemski, Andre´s R. Botello-Mendez,Warren Mar, Georges Ndabashimiye, Sorin Melinte, Jeremy E.P. Dahl, Robert M.K. Carlson, Ekaterina D. Butova, Andrey A. Fokin, Peter R. Schreiner, Jean-Christophe Charlier & Hari C.

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