Danish chemists in molecular chip breakthrough

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The ultra slim carbon material graphene is pivotal in the effort by Copenhagen chemists to build smaller, faster and more green and sustainable electronic devices. Now for the first time, A team led by Kasper Nørgaard, an associate professor at Dept of Chemistry, University of Copenhagen, has made a transistor made from just one molecular monolayer work where it really counts. On a computer chip. Credit: Jes Andersen/University of Copenhagen

Electronic components built from single molecules using chemical synthesis could pave the way for smaller, faster and more green and sustainable electronic devices. Now for the first time, a transistor made from just one molecular monolayer has been made to work where it really counts. On a computer chip.

The molecular integrated circuit was created by a group of chemists and physicists from the Department of Chemistry Nano-Science Center at the University of Copenhagen and Chinese Academy of Sciences, Beijing. Their discovery "Ultrathin Reduced Graphene Oxide Films as Transparent Top-Contacts for Light Switchable Solid-State Molecular Junctions" has just been published online in the prestigious periodical *Advanced Materials*. The breakthrough was made possible through an innovative use of the two dimensional carbon material graphene.

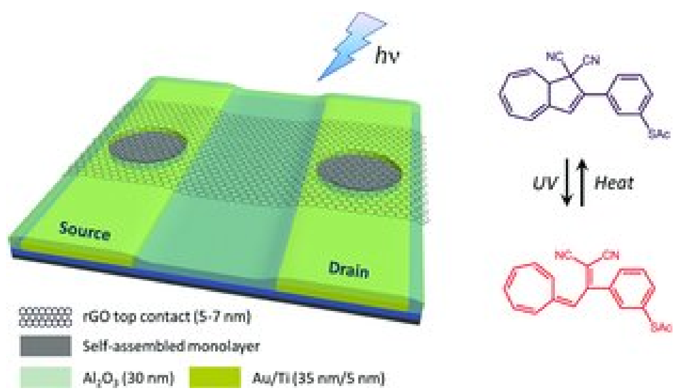
First step towards integrated molecular circuit

Kasper Nørgaard is an associate professor in chemistry at the University of Copenhagen. He believes that the first advantage of the newly developed graphene chip will be to ease the testing of coming molecular electronic components. But he is also confident, that it represents a first step towards proper integrated molecular circuits.

"Graphene has some very interesting properties, which cannot be matched by any other material. What we have shown is that it's possible to integrate a functional component on a graphene chip. I honestly feel this is front page news", says Nørgaard.

The molecular computer chip is a sandwich built with one layer of gold, one of molecular components and one of the extremely thin carbon material graphene. The molecular transistor in the sandwich is switched on and of using a light impulse so one of the peculiar properties of graphene is highly useful. Even though graphene is made of carbon, it's almost completely translucent.

The hunt for transistors, wires, contacts and other electronic components made from single molecules has had researchers working night and day. Unlike traditional components they are expected to require no heavy metals and rare earth elements. So they should be cheaper as well as less harmful to earth, water and animals. Unfortunately it has been fiendishly difficult to test how well these functional molecules work. Until now.



Previously the testing of the microscopic components had researchers resort to a method best compared to a lottery. In order to check whether or not a newly minted molecule would conduct or break a current, they had to practically dump a beakerfull of molecules between two live wires, hoping that at least one molecule had landed so that it closed the circuit.

Lottery method supplanted by precision placement

Using the new graphene chip researchers can now place their molecules with great precision. This makes it faster and easier to test the functionality of molecular wires, contacts and diodes so that chemists will know in no time whether they need to get back to their beakers to develop new functional molecules, explains Nørgaard.

"We've made a design, that'll hold many different types of molecule" he says and goes on: "Because the graphene scaffold is closer to real chipdesign it does make it easier to test components, but of course it's also a step on the road to making a real integrated circuit using molecular components. And we must not lose sight of the fact that molecular components do have to end up in an integrated circuit, if they are going to be any use at all in real life".

More information: onlinelibrary.wiley.com/doi/10 … a.201300607/abstract

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