TU Delft researchers discover new type of molecule: semi-artificial

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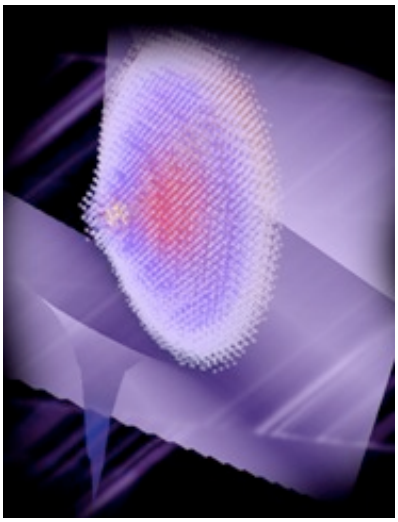
In conjunction with Australian, American and Belgian colleagues, TU Delft and Foundation for Fundamental Research on Matter (FOM) researchers have observed a new type of molecule. It comprises two very different atoms – one natural and one artificial. This remarkable combination was demonstrated in a tiny innovative transistor (FinFET). The scientists publish their findings in Nature Physics this week.



The discovery of the special molecule started when PhD student Gabri Lansbergen of TU Delft's Kavli Institute of Nanoscience conducted highly precise measurements of the electricity that flows through so-called FinFETs.

The FinFETs used are adaptations to an advanced industrial transistor (a MOSFET) and are made by IMEC, the research centre for micro-electronics in Leuven, Belgium. This tiny transistor comprises a silicon nanowire, several dozen nanometres wide, whereby the electricity passes through a single atom (in this case arsenic) under certain conditions. The nanowire is connected to a 'gate'; by applying a voltage to the gate, electrons are allowed to flow through the silicon containing the arsenic atom.

Lansbergen discovered minor disruptions to the electricity passed through the FinFET which are typical of the presence of a single atom in the small transistor's silicon base material. However, the data did not correspond to any of the atoms that this contains.

The mystery was solved with the aid of the University of Melbourne and Purdue University (US). The scientists applied calculation methods developed for the design of a silicon quantum computer. Purdue University simulated the conduct of millions of silicon atoms in the crucial part of the FinFET.

The researchers were therefore able to identify a new hybrid molecule containing two atoms, of which one part is natural and the other artificial. One extremity of the molecule is formed by an arsenic atom which is present in the transistor's silicon base material. The other end of the molecule comprises an artificially-created arsenic atom, formed by the controlled voltage applied to the gate of the transistor.

A natural molecule containing two atoms should be halter-shaped. In this case, however, the hybrid molecule is rounded at the end with the natural arsenic atom, flat at the artificial end and about twenty times larger than a natural molecule.

The calculations did demonstrate that the experiments and theory were largely consistent with each other. This forms a basis for new quantum technology in which atoms can be specifically adapted at quantum level.

TU Delft researchers had already recently succeeded in passing electricity through a single atom using FinFETs. Further development of FinFETs could help enable additional miniaturisation of electronics. This process of miniaturisation may stagnate without fresh breakthroughs in the medium term.

Note to the editor

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