World's smallest diode developed

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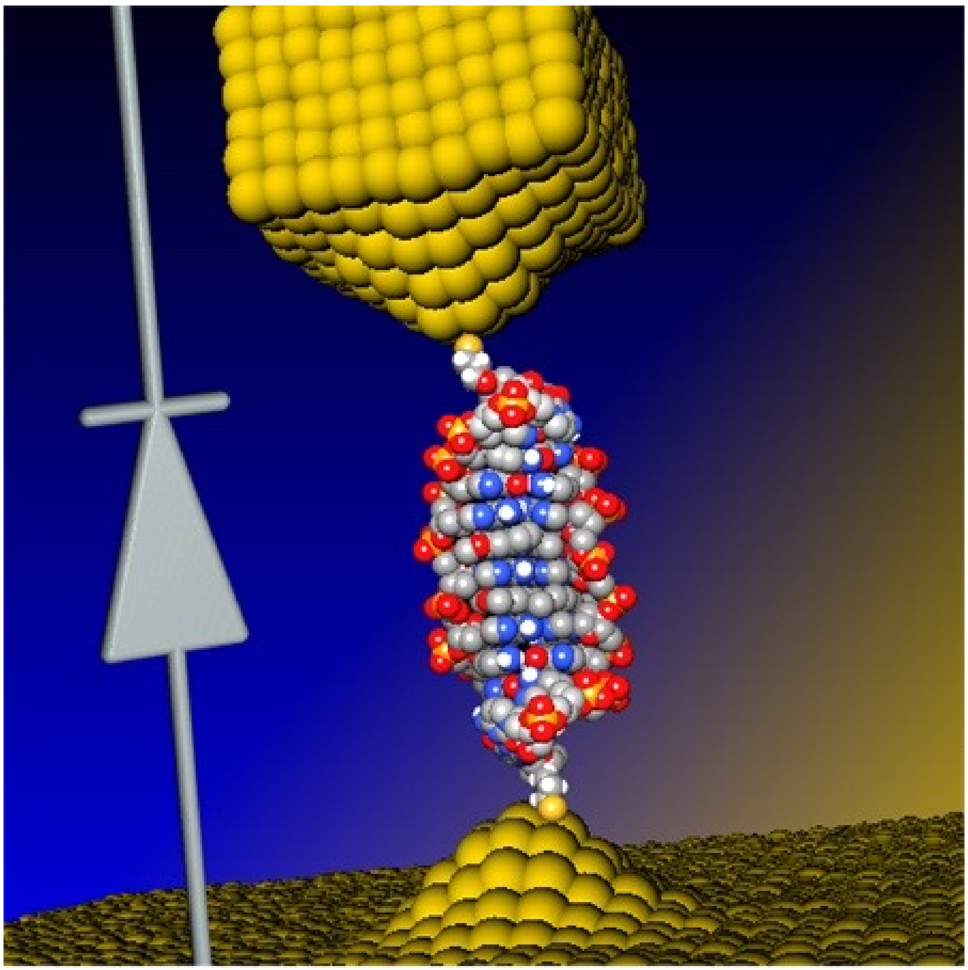

Illustration of the coralyne-intercalated DNA junction used to create a single-molecule diode, which can be used as an active element in future nanoscale circuits. Credit: U. Georgia/Ben-Gurion U.

The world's smallest diode, the size of a single molecule, has been developed collaboratively by U.S. and Israeli researchers from the University of Georgia and Ben-Gurion University of the Negev (BGU).

Their study will be published online in *Nature Chemistry* on April 4, 2016.

"Creating and characterizing the world's smallest diode is a significant milestone in the development of molecular electronic devices," explains Dr. Yoni Dubi, a researcher in the BGU Department of Chemistry and Ilse Katz Institute for Nanoscale Science and Technology. "It gives us new insights into the electronic transport mechanism."

Continuous demand for more computing power is pushing the limitations of present day methods. This need is driving researchers to look for molecules with interesting properties and find ways to establish reliable contacts between molecular components and bulk materials in an electrode, in order to mimic conventional electronic elements at the molecular scale.

An example for such an element is the nanoscale diode (or molecular rectifier), which operates like a valve to facilitate electronic current flow in one direction. A collection of these nanoscale diodes, or molecules, has properties that resemble traditional electronic components such as a wire, transistor or rectifier. The emerging field of single molecule electronics may provide a way to overcome Moore's Law— the observation that over the history of computing hardware the number of transistors in a dense integrated circuit has doubled approximately every two years - beyond the limits of conventional silicon integrated circuits.

Prof. Bingqian Xu's group at the College of Engineering at the University of Georgia took a single DNA molecule constructed from 11 base pairs and connected it to an electronic circuit only a few nanometers in size. When they measured the current through the molecule, it did not show any special behavior. However, when layers of a molecule called "coralyne," were inserted (or intercalated) between layers of DNA, the behavior of the circuit changed drastically. The current jumped to 15 times larger negative vs. positive voltages—a necessary feature for a nano diode. "In summary, we have constructed a molecular rectifier by intercalating specific, small molecules into designed DNA strands," explains Prof. Xu.

Dr. Dubi and his student, Elinor Zerah-Harush, constructed a theoretical model of the DNA molecule inside the electric circuit to better understand the results of the experiment. "The model allowed us to identify the source of the diode-like feature, which originates from breaking spatial symmetry inside the DNA molecule after coralyne is inserted."

More information: Molecular rectifier composed of DNA with high rectification ratio enabled by intercalation, *Nature Chemistry*, DOI: 10.1038/nchem.2480

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