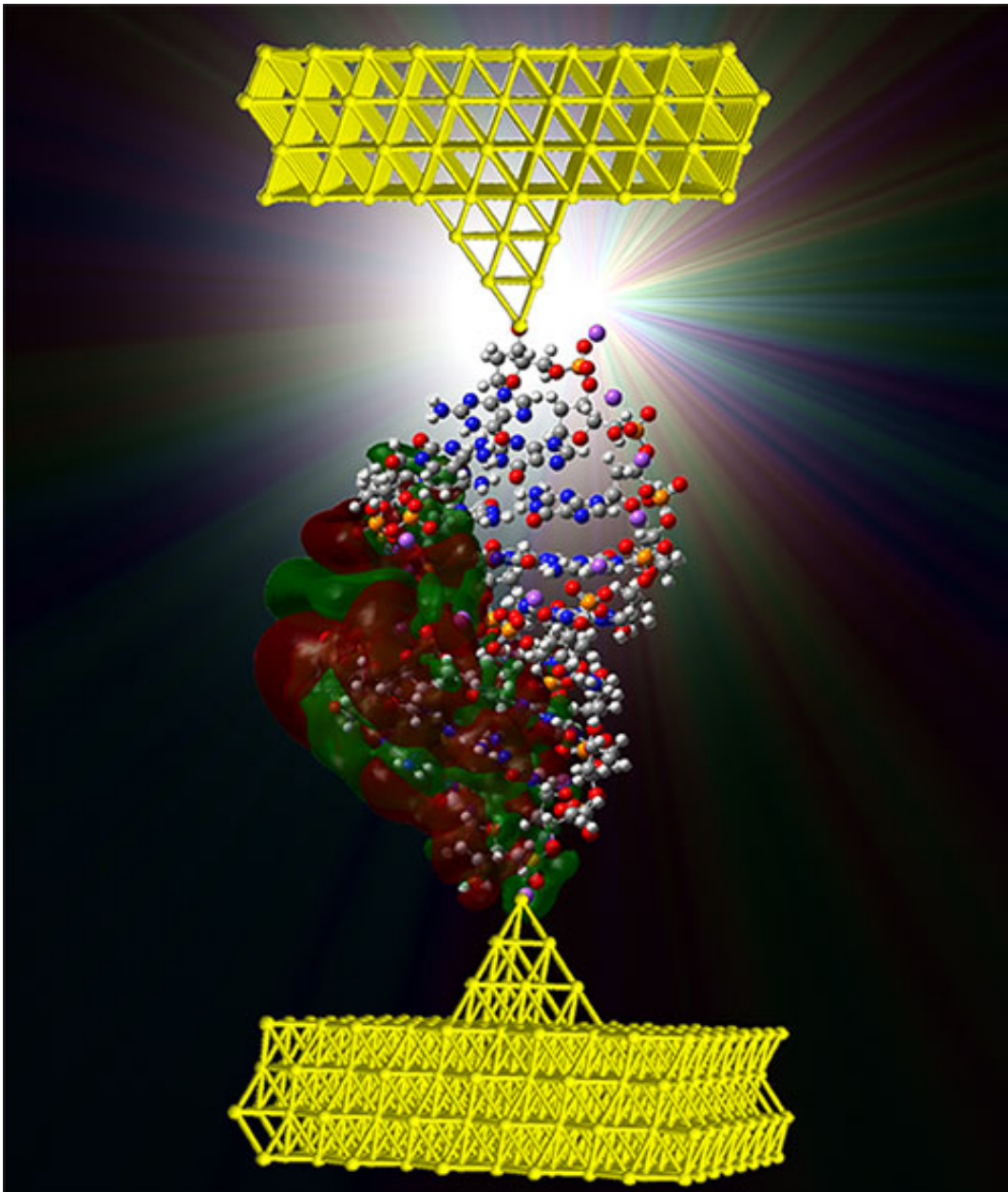


# DNA-based electromechanical switch demonstrated

December 11 2015, by Andy Fell

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The A-form of DNA between two electrodes.

A team of researchers from the University of California, Davis and the University of Washington have demonstrated that the conductance of DNA can be modulated by controlling its structure, thus opening up the possibility of DNA's future use as an electromechanical switch for nanoscale computing. Although DNA is commonly known for its biological role as the molecule of life, it has recently garnered significant interest for use as a nanoscale material for a wide-variety of applications.

In their paper published in *Nature Communications*, the team demonstrated that changing the structure of the DNA double helix by modifying its environment allows the conductance (the ease with which an electric current passes) to be reversibly controlled. This ability to structurally modulate the charge transport properties may enable the design of unique nanodevices based on DNA. These devices would operate using a completely different paradigm than today's conventional electronics.

"As electronics get smaller they are becoming more difficult and expensive to manufacture, but DNA-based devices could be designed from the bottom-up using directed self-assembly techniques such as 'DNA origami'," said Josh Hihath, assistant professor of electrical and computer engineering at UC Davis and senior author on the paper. DNA origami is the folding of DNA to create two- and three-dimensional shapes at the nanoscale level.

"Considerable progress has been made in understanding DNA's mechanical, structural, and self-assembly properties and the use of these properties to design structures at the nanoscale. The electrical properties, however, have generally been difficult to control," said Hihath.

## **New Twist on DNA? Possible Paradigms for Computing**

In addition to potential advantages in fabrication at the nanoscale level, such DNA-based devices may also improve the [energy efficiency](#) of electronic circuits. The size of devices has been significantly reduced over the last 40 years, but as the size has decreased, the power density on-chip has increased. Scientists and engineers have been exploring novel solutions to improve the efficiency.

"There's no reason that computation must be done with traditional transistors. Early computers were fully mechanical and later worked on relays and vacuum tubes," said Hihath. "Moving to an electromechanical platform may eventually allow us to improve the energy efficiency of electronic devices at the nanoscale."

This work demonstrates that DNA is capable of operating as an electromechanical switch and could lead to new paradigms for computing.

To develop DNA into a reversible switch, the scientists focused on switching between two stable conformations of DNA, known as the A-form and the B-form. In DNA, the B-form is the conventional DNA duplex that is commonly associated with these molecules. The A-form is a more compact version with different spacing and tilting between the base pairs. Exposure to ethanol forces the DNA into the A-form conformation resulting in an increased conductance. Similarly, by removing the ethanol, the DNA can switch back to the B-form and return to its original reduced conductance value.

### **One Step Toward Molecular Computing**

In order to develop this finding into a technologically viable platform for electronics, the authors also noted that there is still a great deal of work to be done. Although this discovery provides a proof-of-principle demonstration of electromechanical switching in DNA, there are generally two major hurdles yet to be overcome in the field of molecular electronics. First, billions of active molecular devices must be integrated into the same circuit as is done currently in conventional electronics. Next, scientists must be able to gate specific devices individually in such a large system.

"Eventually, the environmental gating aspect of this work will have to be replaced with a mechanical or electrical signal in order to locally address a single [device](#)," noted Hihath.

**More information:** Juan Manuel Artés et al. Conformational gating of DNA conductance, *Nature Communications* (2015). [DOI: 10.1038/ncomms9870](#)

Provided by UC Davis

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