# DNA Conductivity

## Biomedical Engineering Seminar

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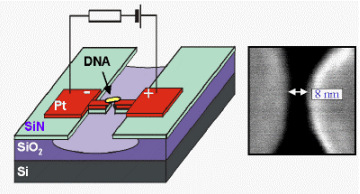
DNA molecule is considered as a promising candidate for the realization of molecular electronics.

There have been a variety of experiments and the results have been as varied and sometimes even contradictory.

Danny Porath, Alexey Bezryadin, Simon de Vries & Cees Dekker from the Department of Applied Sciences, Deft University of Technology, The Netherlands, together published an article in *Nature* discussing an experiment they worked on that proved that DNA is indeed conductive.




In this experiment, 10.4 nm long DNA molecules, each DNA molecule with 30 base pairs, are connected to two metal nano electrodes by electrostatic trapping. Current is absorbed across the electrodes.

Current is measured between the electrodes before the DNA trapping is done and it is found that no current flows in the absence of DNA. To make sure that it was DNA that was conducting and not some other type of ionic compound present within the DNA solution, a set of DNA was treated with DNAse (an enzyme that cuts the double strand) before being trapped. No current was absorbed across the electrodes confirming that it was indeed the DNA that was conducting.

The possibility of ionic conduction through water molecules present in the environment was excluded by performing measurements in vacuum and -20 degrees Celsius.

It was found that at low bias, DNA behaves like an insulator. Beyond the threshold voltage, current rose sharply. The curves obtained from measurements show a non-linear current-voltage relationship that exhibits a voltage gap at low applied voltages. The current-voltage gap becomes larger with increasing temperature, abrupt changes in applied voltages or applying high currents (the reason remains unknown).

Measurements were done on micrometer long DNA "ropes" and on DNA film. They showed that DNA behaves as a good linear conductor but also as a band-gap semiconductor.

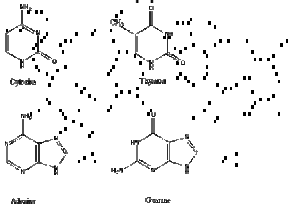
The pi-orbitals of adjacent base pairs form a continuous layer for the electrons to move around in.

> *"… electronic interactions between the bases in the DNA molecule lead to a molecular band where the electronic states* [electrons] *are delocalized over the entire length of the* [DNA] *molecule."*

A fairly simple way to look at the Hole Hoping theory is to consider DNA as a series arrangement of very tiny quantum dots. Though individually these quantum dots possess very little charging energy, their net contribution is significant.

DNA potentially has Extensive application in nano-electronics. Being self assembled and having inherent molecular recognition abilities would help overcome many problems associated with inter-element wiring and positioning on a nanometer scale

Conductive DNA can be engineered by substituting the imino-proton (hydrogen) of each base pair with a metal ion, thereby altering the electrical properties of DNA. This kind of DNA is known as M-DNA. M-DNA can be used for all device application.



It's important to remember that the electrical properties of DNA still remain contradictory

References

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