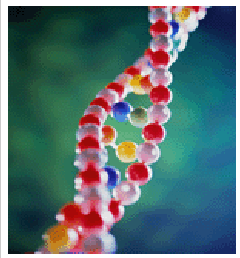
DNA goes spintronic

Jul 23, 2002

DNA molecules could soon add 'spintronic' effects to their repertoire of surprising electronic properties. In simulations performed by Michael Zwolak and Massimiliano Di Ventra of Virginia Polytechnic Institute and State University in the US, the current flowing through DNA molecules jumped by 26% when the spins of the electrons were flipped. Previous studies have shown that DNA can act as a superconductor and a semiconductor (M Zwolak and M Di Ventra 2002 *Appl. Phys. Lett.* **81** 925).



Conventional electronic devices only exploit the charge of electrons. But much more powerful devices could be built if the 'spin' of electrons – which can be either +1/2 or -1/2 – could also be controlled. When the spins of electrons are aligned in one direction – or 'polarized' – by a magnetic field, the resistance they experience when they travel through a conductor is different to that experienced by electrons polarized in the opposite direction.

This effect is known as magnetoresistance and can be studied by sandwiching a conductor between two ferromagnetic electrodes – a device known as a spin valve. When these electrodes are placed in a magnetic field, the spins of the electrons that they contain become polarized. If a voltage is then applied across the electrodes, the polarized electrons can flow through the conductor, from one electrode to the other.

To see how polarized currents would flow through DNA molecules, Zwolak and Di Ventra considered two spin valves – one with iron electrodes and one with nickel electrodes – in which DNA was the conductor. They calculated the current that would flow through the DNA molecules when the electrodes in each spin valve were magnetized first in the same direction – or 'parallel' – and then in opposite directions – or 'anti-parallel'.

The researchers found that the current flowing through the DNA in a nickel-based spin valve would increase by up to 26% when the magnetization of the electrodes was switched from anti-parallel to parallel. In an iron-based spin valve, the current would increase by up to 16% for a similar switch. This shows that electrons would be able to travel through DNA more easily when both the source and drain electrodes were magnetized in the same direction.

Zwolak and Di Ventra believe that it should be possible to observe these effects experimentally, and hope that their results will stimulate further studies into the electrical properties of DNA and their potential use in molecular electronics devices of the future.

About the author

Katie Pennicott is Editor of PhysicsWeb