Industrial dye holds the key to advancing spintronics

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Commonly used industrial dyes hold the key to advancing the new science of 'spintronics', say researchers working on a new a £2.5 million study.

Spintronics holds out the possibility of a range of future applications, such as quantum computing, which aims to deliver secure, low-power computers capable of processing much larger quantities of data than is currently possible. Scientists believe that sensitive new biosensors able to analyse blood or urine samples rapidly and accurately could also be developed as a result of this work.

The new Basic Technology grant awarded by the Engineering and Physical Sciences Research Council will support research into the magnetic properties of metal atoms found in industrial dyes such as Metal Phthalocyanine (MPc), a blue dye used in clothing. The team from the London Centre for Nanotechnology - a joint venture between Imperial College London and University College London - and the University of Warwick believes that finding ways to control and exploit these molecules will allow spintronics to be applied in new ways.

The science of spintronics focuses on storing, processing and receiving information by using magnetic fields, electrical currents, light and microwaves to control the spin of electrons. In contrast, conventional electronics, such as those in the integrated circuits of computers or mobile phones, do this by controlling the electrical charge of electrons rather than their spin.

Spintronics has the potential to significantly increase the amount of information a computer can store and process, because spin gives an electron two fundamental states instead of one - spin up and spin down. This means that information can be stored in arbitrary combinations of these two states, dramatically increasing the amount of information each electron can encode.

While spintronics can already be found in computer hard drives, which rely on magnets to store and read information, implementing it more widely in conventional electronics to process information is difficult. This is because the inorganic semiconductors such as silicon currently used in conventional electronics are not magnetic, except at very low temperatures, and therefore cannot control electron spin.

In order to advance spintronics, materials which combine both magnetic and semiconducting properties need to be found. The researchers believe that MPc, which is an organic semiconductor, holds the answer, and now aim to exploit the spin inherent in its metal atoms. Previous research carried out by this team has already demonstrated that spins in MPc can interact and these interactions can be switched – such switching is the first step towards use in information storage and logic operations.

The organic semiconductors to be used by the team for spintronics are very similar to those successfully used in solar cells and LEDs for ultra-flat wide screen TVs with low power consumption, and which are leading the way into cheap 'plastic electronics'. This means that the benefits of organic semiconductors will be spread to more components of everyday electronics products such as computers and mobile telephones. Dr Sandrine Heutz from Imperial College London’s Department of Materials and London Centre for Nanotechnology said:

"Molecules incorporate many different functionalities necessary for spintronics, are cheap and can be processed easily. We believe they could have a real edge in the quest for smaller, faster, and more energy efficient devices."

The grant will also enable research into the use of molecular spintronics to develop highly sensitive biosensors. The team believes that when subjected to microwaves the metal atoms in MPc will display different magnetic interactions with different chemicals. This could pave the way for sensing devices able to rapidly and accurately identify chemicals such as drugs in blood or urine samples.

Dr Chris Kay, a biologist from University College London who is also working in the London Centre for Nanotechnology said:

“Our proposed plastic bio-assay together with inexpensive microwave technology should, for certain biological problems, put straightforward few-molecule sensitivity within the reach of far more laboratories than currently available methods.”

Professor Tim Jones, from the University of Warwick concludes:

“Organic electronics has evolved very rapidly over the last 2 decades, from research to practical devices. We are delighted that this award will enable us to explore a new range of applications.”

Source: University of Warwick

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