A slice of carbon could work wonders with chips

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Move over silicon: the hottest new material in electronics could be sitting inside the humble pencil. At the Institute of Physics' Condensed Matter and Materials Physics conference at the University of Exeter on Thursday 20 and Friday 21 April, Andre Geim of the University of Manchester and his colleagues claim that graphite, the silvery black, soft form of carbon known for thousands of years, could yield a new generation of microelectronic devices, as well as unveiling unprecedented effects in quantum physics.

But this is no ordinary graphite. The stuff in ordinary pencils consists of stacked sheets of carbon, each sheet made up of atoms linked together to form a hexagonal network like chicken wire. Geim and colleagues have discovered that interesting and potentially useful electronic behaviour appears when these sheets are separated and laid out one sheet at a time.

A single graphite sheet is called graphene. This same gossamer-thin material has attracted intense interest over the past ten years or so when it is rolled up into long, hollow cylinders called carbon nanotubes. Nanotubes are predicted to be extremely strong, and they conduct electricity in ways that have already been exploited to make electronic devices smaller than any made by conventional silicon-chip fabrication methods.

But Geim and colleagues say that the appeal of this kind of carbon lies not with nanotubes in themselves, but with the underlying fabric: the flat sheets of graphene. They have developed methods for splitting graphite apart into its separate layers and lying them down flat on a surface, where their electrical properties can be studied. A graphene sheet is electrically conducting, behaving essentially like a two-dimensional metal. But it is a strange kind of metal, with properties dictated by quantum mechanics. For example, even if there are no mobile electrons to carry an electrical current, the electrical conductivity can never fall below a certain minimum value: it is like an electron gate that can never be fully closed.

And the Manchester researchers have shown that graphene can be fashioned into a device called a spin valve, which discriminates between mobile electrons according to their spin. Spin is a quantum-mechanical property of electrons, and can take either of two values - somewhat akin to magnets that can orient their poles in either of two opposed directions. Conventional electronics takes no account of electron spin; but it has been suggested that a spin-dependent form of electronics, called spintronics, could provide new and powerful ways to process information. A graphene spin valve could act rather like a spintronic filter that lets a current pass only if the electrons have the correct spin.

Source: Institute of Physics

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