Atom-thick sheets unlock future technologies

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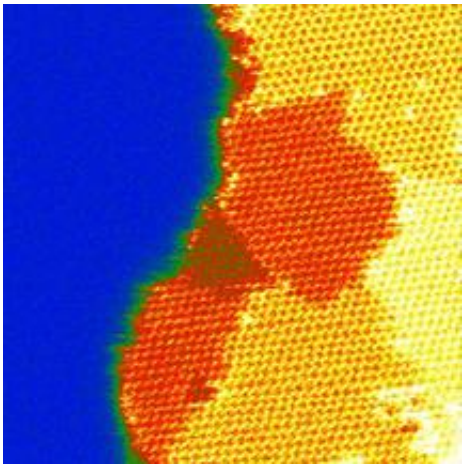

Nanosheet imaged with an electron microscope (STEM).

(PhysOrg.com) -- A new way of splitting layered materials, similar to graphite, into sheets of material just one atom thick could lead to revolutionary new electronic and energy storage technologies.

An international team, led by Oxford University and Trinity College Dublin scientists, has invented a versatile method for creating these one-atom thick 'nanosheets' from a range of materials using mild ultrasonic pulses, like those generated by jewellery cleaning devices, and common solvents. The new method is simple, fast, and inexpensive, and could be scaled up to work on an industrial scale.

The team publish a report of the research in this week's *Science*.

Each one-millimetre-thick layer of graphite is made up of around three million layers of graphene – a flat sheet of carbon one atom thick – stacked one on top of the other.

'Because of its extraordinary electronic properties graphene has been getting all the attention, including a recent Nobel Prize, as physicists hope that it might, one day, compete with silicon in electronics,' said Dr Valeria Nicolosi of Oxford University's Department of Materials, who led the research with Professor Jonathan Coleman of Trinity College Dublin. 'But in fact there are hundreds of other layered materials that could enable us to create powerful new technologies.'

Professor Coleman, of Trinity College Dublin, said: 'These novel materials have chemical and electronic properties which are well suited for applications in new electronic devices, super-strong composite materials and energy generation and storage. In particular, this research represents a major breakthrough towards the development of efficient thermoelectric materials.'

There are over 150 of these exotic layered materials – such as Boron Nitride, Molybdenum disulfide, and Tungsten disulfide – that have the potential to be metallic, semi-metallic or semiconducting depending on their chemical composition and how their atoms are arranged.

For decades researchers have tried to create nanosheets of these kind of materials as arranging them in atom-thick layers would enable us to unlock their unusual electronic and thermoelectric properties. However, all previous methods were extremely time consuming and laborious and the resulting materials were fragile and unsuited to most applications.

'Our new method offers low-costs, a very high yield and a very large throughput: within a couple of hours, and with just 1 mg of material, billions and billions of one-atom-thick graphene-like nanosheets can be

made at the same time from a wide variety of exotic layered materials,' said Dr Nicolosi.

Nanosheets created using this method can be sprayed onto the surface of other materials, such as silicon, to produce ‘hybrid films’ which, potentially, enable their exotic abilities to be integrated with conventional technologies. Such films could be used to construct, among other things, new designs of computing devices, sensors or batteries.

A report of the research, 'Two-dimensional nanosheets produced by liquid exfoliation of layered materials', is published in the 4 February edition of the journal *Science*.

Provided by University of Oxford