Conductivity at the edges of graphene bilayers

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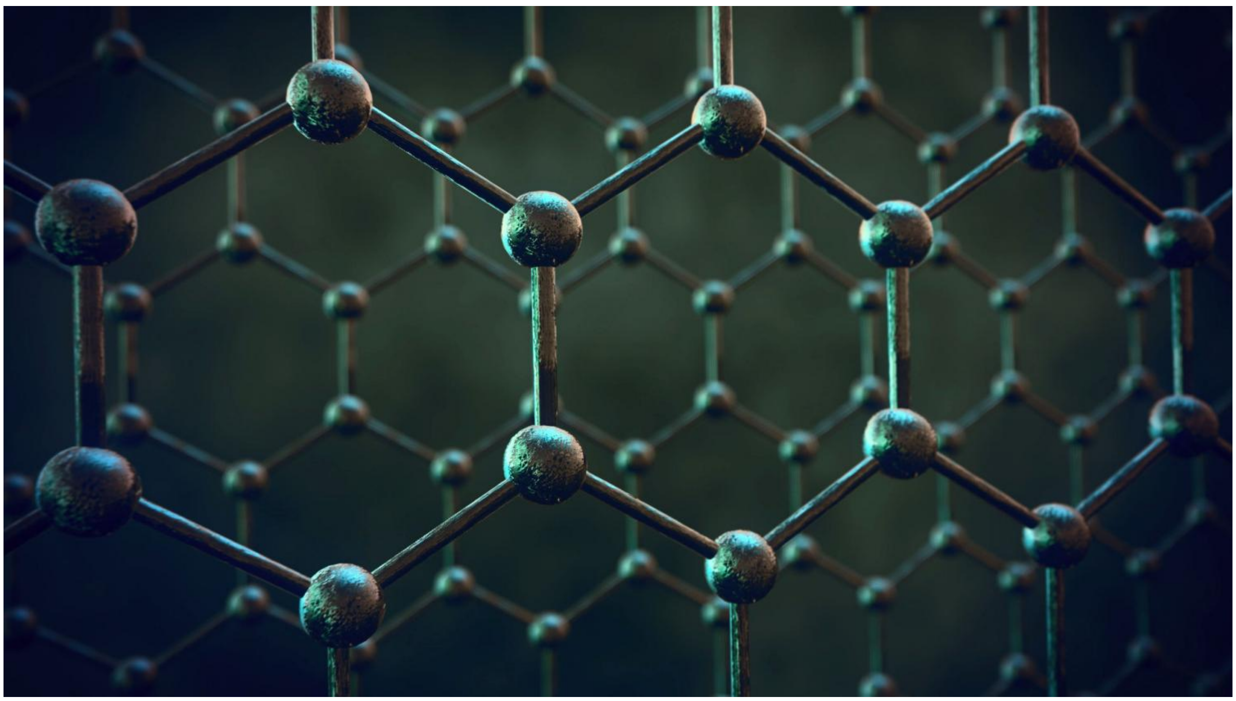

This visualisation shows layers of graphene used for membranes. Credit: University of Manchester

The conductivity of dual layers of graphene greatly depends on the states of carbon atoms at their edges; a property which could have important implications for information transmissions on quantum scales.

Made from 2-D sheets of carbon atoms arranged in honeycomb lattices, graphene displays a wide array of properties regarding the conduction of heat and electricity.

When two layers of graphene are stacked on top of each other to form a 'bilayer,' these properties can become even more interesting. At the edges of these bilayers, for example, atoms can sometimes exist in an exotic state of matter referred to as the 'quantum spin Hall' (QSH) state, depending on the nature of the interaction between their spins and their motions, referred to as their 'spin-orbit coupling' (SOC). While the QSH state is allowed for 'intrinsic' SOC, it is destroyed by 'Rashba' SOC. In an article recently published in *EPJ B*, Priyanka Sinha and Saurabh Basu from the Indian Institute of Technology Guwahati showed that these two types of SOC are responsible for variations in the ways in which graphene bilayers conduct electricity.

For nanoribbons of bilayer graphene, whose edge atoms are arranged in zigzag patterns, the authors showed that the bands of electron energies which are allowed and forbidden are significantly different to those found in monolayer graphene. For intrinsic SOC, the QSH state even caused atoms in the zigzag to have a gap between these bands, which disappeared in odd atoms. However, this asymmetry disappeared for Rashba SOC, which changed the relationship between the energy required to add an electron to the bilayer, and its conductivity.

This conduction sensitivity to the states of edge atoms shows that graphene bilayers could be particularly useful for spintronics applications. This field studies how quantum spins can be used to efficiently transmit information, which is of particular interest to researchers in fields like quantum computing. Sinha and Basu also found that the characteristic SOC behaviours they uncovered persisted with or without voltage across the bilayers, which dispelled theories that this aspect could prevent the QSH state from forming. Their work furthers our knowledge of graphene bilayers, potentially opening up new areas of research into their intriguing properties.

More information: Priyanka Sinha et al, Study of edge states and conductivity in spin-orbit coupled bilayer graphene, *The European Physical Journal B* (2019). DOI: 10.1140/epjb/e2019-100287-6

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