A modified device fabrication process achieves enhanced spin transport in graphene

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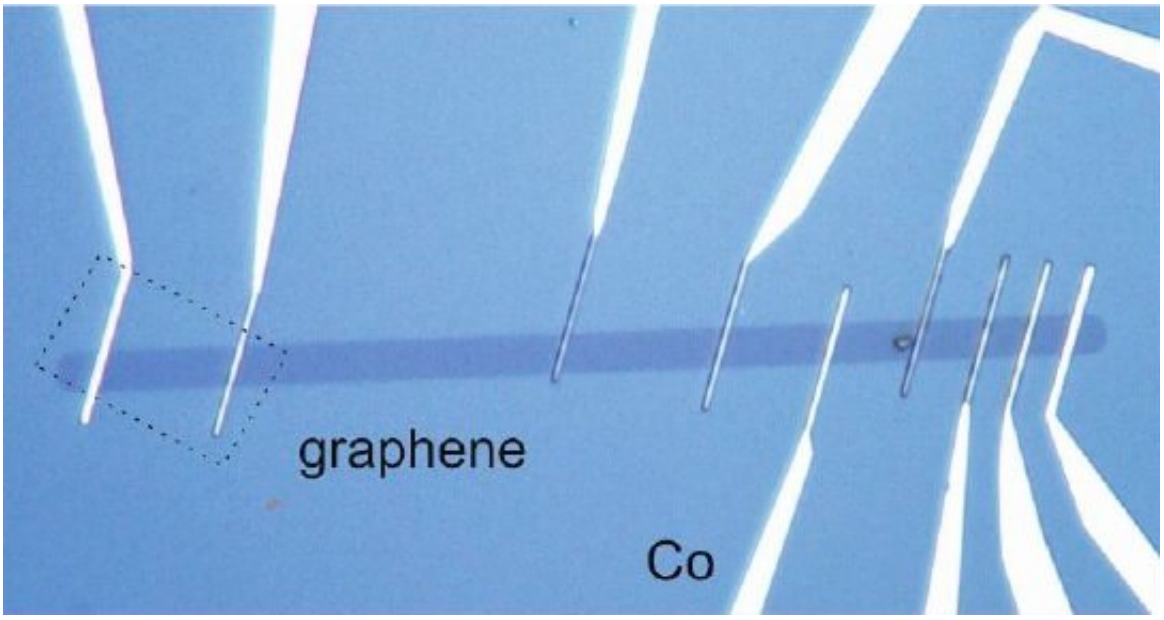

Image of a 125 μm long graphene stripe with cobalt contacts. Credit: ICN2

Researchers from the ICN2 Physics and Engineering of Nanodevices Group have proposed a modified graphene-based nanodevice fabrication technique that increases up to three times the spin lifetime and relaxation length compared to previous work of the same kind. The work was fruit of the collaboration with Imec and K.U. Leuven (Belgium). The results have been published in *2-D Materials* and are expected to empower investigations on large-scale spintronic applications.

Spintronics amplifies the potential of traditional electronics by exploiting the electron's spin degree of freedom, in addition to the usual state of charge. In the end, the goal is to obtain devices to store, process and read information, but with enhanced characteristics such as lower power consumption, less heat dissipation, higher speed, etc. Although spintronics has not yet become widespread, some current devices are based on this new approach, such as magnetic hard disks, magnetic random access memories and magnetic sensors with varied applications in industrial environments, robotics and the automotive industry.

Graphene is a promising material in this field. Spins can flow efficiently in it over long distances, meaning that they do not change their state for a relatively long time. Due to its large-scale production, CVD graphene is becoming popular for spintronic devices. However, impurities arising from the graphene growth and the device fabrication process limit its performance.

A team of scientists from the ICN2 Physics and Engineering of Nanodevices Group, led by ICREA Prof. Sergio O. Valenzuela, has proposed a high-yield device fabrication process from CVD graphene that has improved its spin parameters substantially. The work, whose first author is Zewdu M. Gebeyehu, was fruit of a collaboration with Imec and K.U. Leuven (Belgium). The results have been published in *2-D Materials*.

They demonstrate a spin signal measured across a 30 μm long channel with room-temperature spin lifetimes of up to three nanoseconds and spin relaxation lengths of up to 9 μm in monolayer graphene on SiO_2/Si substrates. These spin parameters are the highest values for any form of graphene (both exfoliated and CVD graphene) on a standard SiO_2/Si substrate.

To achieve this enhanced spin performance, the researchers used CVD

graphene grown on a platinum foil and modified the device fabrication technique to reduce the impurity levels associated with the graphene growth and fabrication steps. The latter requires the optimization of several standard processes, involving the preselection of high-quality uniform graphene with low level of impurities, an etching step combining e-beam lithography and oxygen plasma and a suitable post-annealing in high vacuum. The approach can be scaled and allows a highly reproducible fabrication of devices, which is the main requirement for potential industrialization.

The improvement on the spin parameters together with the reproducibility of the device fabrication process brings us closer to the realization of complex circuit architectures for spintronic devices such as spin logic and logic-in-memory for beyond CMOS computing.

More information: Z M Gebeyehu et al. Spin communication over 30 µm long channels of chemical vapor deposited graphene on SiO2, *2-D Materials* (2019). DOI: 10.1088/2053-1583/ab1874

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