Contribution (Invited)

A two-dimensional field-effect spin transistor

Luis E. Hueso[1,2*], Wenjing Yan[1], Oihana Txoperena[1], Félix Casanova[1,2]

[1]CIC nanoGUNE, San Sebastian, Spain
[2]IKERBASQUE, Basque Foundation for Science, Bilbao, Spain
[*]l.hueso@nanogune.eu

The integration of the spin degree of freedom in charge-based electronic devices has revolutionised both sensing and memory capability in microelectronics [1]. However, any further development in spintronic devices requires electrical manipulation of spin current for logic operations. The approach followed so far, inspired by the seminal proposal of the Datta and Das spin modulator [2], has relied on the spin-orbit field as a medium for electrical control of the spin state [3]. However, the still standing challenge is to find a material whose spin-orbit-coupling (SOC) is weak enough to transport spins over long distances, while also being strong enough to allow their electrical manipulation.

In this talk I will show a radically different approach in the form of an atomically thin van der Waals heterostructure [4], which combines the superior spin transport properties of graphene [5] with the strong SOC of the semiconducting MoS_2 [6].

Our results show how the spin transport in the graphene channel is modulated between ON and OFF states by tuning the spin absorption into the MoS_2 layer with a gate electrode. Our demonstration of a spin field-effect transistor using two-dimensional materials identifies a new route towards spin logic operations for beyond CMOS technology [7].

References

[1] A. Fert, *Rev. Mod. Phys.* **80**, 1517 (2008)

[2] S. Datta, B. Das, *Appl. Phys. Lett.* **56**, 665 (1990)

[3] H.C. Koo et al., *Science* **325**, 1515 (2009)

[4] A.K. Geim, I.V. Grigorieva, *Nature* **449**, 419 (2013)

[5] W. Han et al., *Nature Nanotech.* **9**, 794 (2014)

[6] X. Xu, et al., *Nature Phys.* **10**, 343 (2014)

[7] W. Yan, O. Txoperena, L.E. Hueso, F. Casanova, *Nature Communications* **7**, 13372 (2016)