Spintronics by interface engineering

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Graphene and magnetoelectric multiferroics are promising materials for spintronic devices with high performance and low energy consumption. A very long spin diffusion length and high carrier mobility make graphene attractive for spintronics. The coupling between ferroelectricity and magnetism, which characterises magnetoelectrics, opens the way towards unique device architectures.

In this talk, we combine the features of both materials by investigating from first principles the interface between graphene and $BaMnO_3$, a magnetoelectric multiferroic. We show [1] that electron charge is transferred across the interface and magnetization is induced in the graphene sheet due to the strong interaction between C and Mn. Depending on the relative orientation of graphene and $BaMnO_3$, a quasi-half-metal or a magnetic semiconductor can be obtained. A remarkably large proximity induced spin splitting of the Dirac cones (~300 meV) is achieved. We also show how doping with acceptors can make the high-mobility region of the electronic bands experimentally accessible.

This suggests a series of possible applications in spintronics (e.g. spin filters, spin injectors) for hybrid organic-multiferroic materials and reveals hybrid organic-multiferroics as a new class of materials that may exhibit exotic phenomena such as the quantum anomalous Hall effect and a Rashba spin-orbit induced topological gap.

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References

[1] Z. Zanolli, Sci. Rep., 6 (2016) 31346

Figures

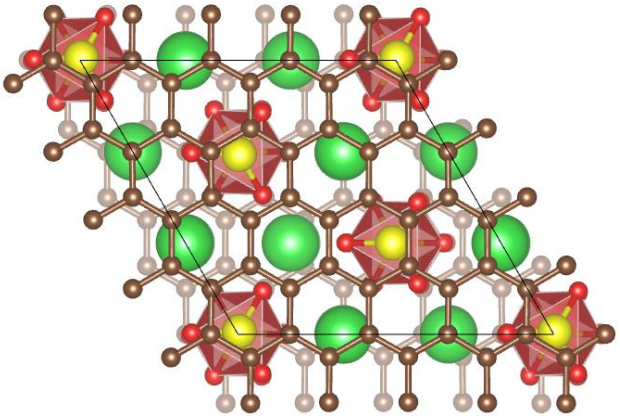

Figure 1: Relaxed structure of the graphene-$BaMnO_3$ interface (top view). Color code is: Gold: C, Green: Ba, Yellow: Mn, Red: O. [1]

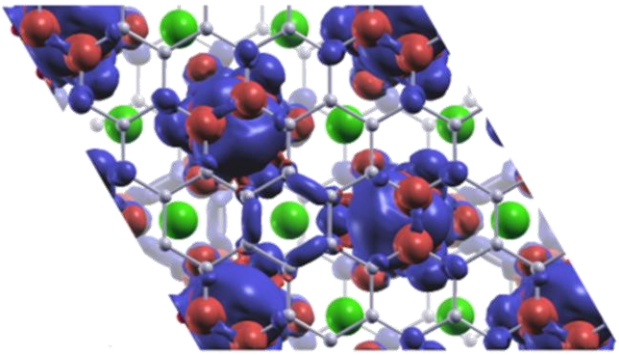

Figure 2: Spin density ($\rho\uparrow - \rho\downarrow$) of the graphene-$BaMnO_3$ interface (top view). Blue and red indicate positive and negative sign isodensities. Spin polarization is induced in the pristine C network from the underlying Mn atoms [1].