Quantum Manipulation of Molecular Graphene

Lapo Bogani
Michael Slota, Federico Lombardi, Simen Sopp, Alessandro Lodi, Tian Pei, Pascal Gehring, Klaus Müllen, Akimitsu Narita
Department of Materials, University of Oxford
lapo.bogani@maerials.ox.ac.uk

Magnetic states in graphene nanostructures have undergone intense theoretical scrutiny, because their coherent manipulation would be a milestone for spintronic and quantum computing devices. In nanoribbons, experimental investigations are however hampered by lack of the required atomic control of the edges, and that the proposed graphene terminations are chemically unstable. Several questions remain thus unsolved: how can molecular spins be assembled into hybrid structures? What is the influence of the graphene environment on the spin? Can molecules be used to control coherent currents in graphene devices? Here we try to provide an answer to these questions, exploring spin-graphene interactions by using molecular magnetic materials.
Here we show our results using bottom-up shaping of graphene, first by graphene nanoribbons made via molecular routes. We observe the predicted delocalized magnetic edge states, and comparison with a non-graphitized reference material allows clear identification of fingerprint behaviours.[1] We quantify the spin-orbit coupling parameters, define the interaction patterns, and unravel the spin decoherence channels. We then show how such molecular structures can be included into molecular devices, producing magnetoresistive effects that are opposite to non-molecular devices.[2] Even without any optimization, the spin coherence time is in the μs range at room temperature, and we perform room temperature quantum inversion operations between spins [3].

References

[1] M. Slota *et al*. Nature 557, 691 (2018).
[2] T. Pei *et al.* Submitted.
[3] F. Lombardi *et al.* Science, (2019).

Figures

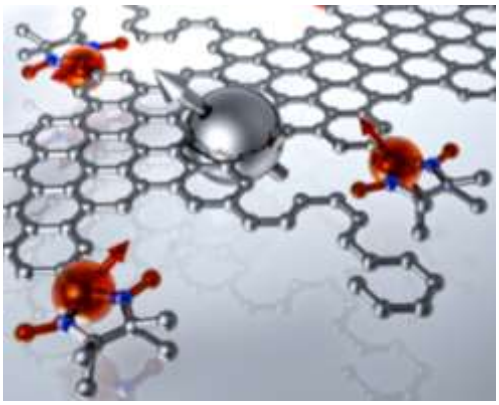

Figure 1: Molecular graphene magnetic ribbons.