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New tools for the chemical modification of 2D materials

Emilio M. Pérez
C/Faraday 9, Ciudad Universitaria de Canto Blanco, E28049 Madrid, Spain
emilio.perez@imdea.org

The extraordinary properties of graphene and transition metal dichalcogenides (TMDCs) can be further improved/tuned by decoration with adequate molecular entities. [1] However, the chemistry of 2D materials remains quite a challenge, in particular due to the typically low reactivity -that makes them stable- and the large number of identical atoms -which hinders selective functionalization.

In this presentation, we will describe a method to functionalize graphene covalently with exquisite (>97%) atomic selectivity and yield (92%). The periodic landscape is provided by a single monolayer of graphene grown on Ru(0001) that presents a moiré pattern due to the mismatch between the carbon and ruthenium hexagonal lattices. The moiré contains periodically arranged areas where the graphene–ruthenium interaction is enhanced and shows higher chemical reactivity.[2] Furthermore, we will show how this type of functionalized graphene acts as a catalyst for an unusual and reversible C-C bond forming reaction.[3]

With regards to TMDCs, we will describe improved methods for their production through liquid-phase exfoliation (LPE),[4] and describe strategies for their noncovalent[5] and covalent[6] functionalisation. The covalent functionalisation is very mild (room temperature) and exploits the inherent soft-nucleophilicity of sulfur to functionalize MoS_2 and WS_2 with the prototypical electrophilic counterpart of S: maleimides. Finally, we will report simple strategies to construct functioning electronic devices from colloidal suspensions of 2D materials obtained by LPE.[7]

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