The honeymoon of 2D materials and supramolecular science: hybrid materials with tunable properties

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2D materials possess unique electronic, optical and mechanical properties, making them crucial components for new disruptive technologies in opto-electronics, sensing, energy and catalysis. Despite being extraordinary, these physical and chemical properties can be hardly modified or modulated. Yet, such a tuning can be achieved by interfacing 2D materials with functional molecules, by pursuing covalent or non-covalent strategies.
My lecture will review our recent findings on:
(i) The development of artificial heterostructure devices with a variety of different electronic and optical properties by self-assembly of atomically precise supramolecular lattices on CVD graphene or MoS_2. This physisorption based approach made it possible to generate controllable 1D periodic potentials in the resulting organic–inorganic hybrid stimuli-responsive heterostructures.
(ii) The realization of layer-by-layer multifunctional 3D assemblies containing 2D materials can be realized through the covalent functionalization of the basal plane of 2D materials with rigid molecular pillars. The ad hoc functionality embedded by chemical design in the molecular pillars makes it possible to generate highly porous foams for selective ion sensing, pressure sensing and energy applications.
Finally, I will discuss the challenges and opportunities towards the realization of novel hybrid multifunctional/multiresponsive materials and devices based on the combination of 2D materials and (supra)molecular systems.

Figures

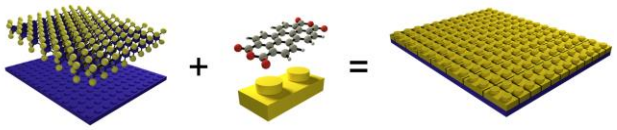

Figure 1: The combination of 2D materials with suitably designed molecules enables the generation of physisorbed superlattices, yielding new hybrid multifunctional materials and devices.