Optically-tunable periodic potentials in hybrid van der Waals heterostructures

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The rise of graphene and related 2D materials makes it possible to form heterostructures held together by weak interplanar van der Waals (vdW) interactions.[1] Within such vdW heterostructures, currently assembled by mechanical superposition of different layers, periodic potentials naturally occur at the interface between the 2D materials. [2] These potentials significantly modify the electronic structure of the individual 2D components within the stack, thus offering the possibility to build up hybrid and novel materials with unique properties.
Here we take a different approach by showing that pre-programmable and optically-tunable periodic potentials arise in bi-layered structures formed by supramolecular lattices (SLs) over graphene, making them the hybrid equivalent of fully-inorganic vdW heterostructures.[3] In particular, we employ a photoreactive molecule ideally suited to form a SL that induces a 1D-modulated gating effect on graphene with single domains extending over areas exceeding 10^4 nm^2 and stable at ambient conditions. The amplitude and sign of the potential can be modified without altering its periodicity by simply irradiating the photoreactive molecule in different solvents prior to the SL formation, resulting in a photo-induced modulation of the superlattice. Such approach for tailoring the periodic potential is easily applicable to other 2D materials, highlighting the rich prospects that molecular design offers to create ad-hoc heterostructures.

References

[1] K. S. Novoselov, *et al.*, Science 353 (2016), 461
[2] M. Yankowitz, *et al.*, Nat. Phys. 8, (2012) 382
[3] M. Gobbi et al., under review.

Figures

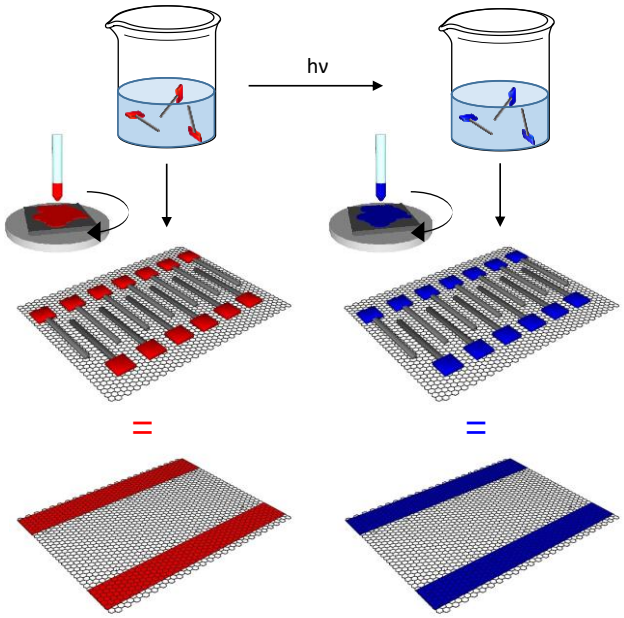

Figure 1: Cartoon of our approach for the formation of optically-tunable periodic potentials in hybrid organic/inorganic heterostructures.