When molecular science meets 2-D materials: orchestrating multiple functions

Paolo Samorì

ISIS, Université de Strasbourg & CNRS, 8 allée Gaspard Monge, 67000 Strasbourg, France.

The combination of the molecular science with 2-dimensional materials, by mastering the supramolecular approach, allows the tuning of the dynamic physical and chemical properties of 2D materials, making it possible to generate multifunctional hybrid systems for applications in (opto)electronics and energy.[1] Towards this end both covalent and non-covalent strategies can be exploited. My lecture will review our recent findings on:
(i) The harnessing of the yield of exfoliation of graphene in liquid media by mastering the supramolecular approach via the combination with suitably designed functional molecules possessing high affinity for the graphene surface, leading ultimately to the bottom-up formation of optically responsive graphene based nanocomposites for electronics. [2]
(ii) The combination of bottom-up grown copper nanowires with graphene oxide sandwiched in a layer-by-layer fashion, followed by a mild reduction in water, yielded flexible hybrid electrodes with transparencies and conductivities matching those of indium-tin oxide. As a proof-of-concept, such hybrid structures have been used as electrodes in electrochromic devices.[3]
(iii) 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. This approach made it possible to generate controllable 1D periodic potentials in the resulting organic–inorganic hybrid heterostructures.[4]
(iv) The exploitation of thiol-chemistry to covalently graft functional molecules to the basal plane of MoS_2.[5]
Our approaches provide a glimpse on the chemist's toolbox to generate multifunctional 2D materials based nanocomposites with ad-hoc properties to address societal needs in electronics and energy applications.

References:

[1] (a) *Chem. Soc. Rev.* **2014**, *43*, 381–398 (b) *Adv. Mater.*, **2016**, *28*, 6030–6051.

[2] (a) *Angew. Chem. Int. Ed.* **2014**, *53*, 10355–10361 (b) *Small* **2015**, *11*, 1691-1702. (c) *Nat. Commun.* **2016**, *7*, 11090. (d) *Nat. Commun.* **2016**, *7*, 11118.

[3] (a) *Adv. Mater.* **2017**, in press (DOI : *10.1002/adma.201703225)*

[4] *Nat. Commun.* **2017**, *8*, 14767.

[5] *Adv. Mater.* **2017**, *29*, 1606760.