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Complex dynamic multicomponent supramolecular nanomaterials: tailoring low dimensional multifunctional nanostructures

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The development of multicomponent thus multifunctional carbon-based nanomaterials via the full control over the architecture vs function relationship can be further modulated and leveraged by using light-stimuli as a route towards the realization of smart and high performing (opto)electronic (nano)devices, sensors and logic gates. However, their practical use requires the optimization of the self-assembly of multimodular architectures at surfaces using non-conventional methods, their controlled manipulation and responsiveness to external stimuli, and the quantitative study of various physico-chemical properties at distinct length- and time-scales. 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 ad-hoc functional molecules possessing high affinity for the graphene surface, leading ultimately to the bottom-up formation of optically responsive graphene based nanocomposites for electronics. [1] The physisorption of conjugated polymers on already pre-patterned liquid processed graphene nanopatches exhibiting tunable ionization energy obtained with thermal annealing, is a viable strategy to fabricate non-volatile memory devices.[2]

(ii) Since the sensing occurs via molecular recognition, the sensitivity in humidity and (heavy) metal sensing can be harnessed by using low dimensional structures exhibiting a high surface area, fully decorated with receptors. Electroactive fibers obtained from an amphiphilic monomolecular dyad showed unique characteristics as resistive humidity sensors combining a response rate as fast as 26 ms with an exponential growth of the current from 0 to, at least, 75% of relative humidity (RH). In this RH range the current changes up to 7 orders of magnitude, i.e. from a few pA to tens mA, demonstrating an extremely high sensitivity to humidity variations.[3]

(iii) The tailoring of multicomponent films comprising photochromic systems and semiconducting molecules, and their exploitation to realise multifunctional devices such as optically switchable field-effect transistors and memories. [4]

Our approaches provide a glimpse on the chemist's toolbox to generate molecular nanomaterials with ad-hoc properties for the fabrication of high performing multifunctional nanodevices.

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