Smart molecular materials in van der Waals heterostructures

Eugenio Coronado
Carla Boix, Samuel Mañas-Valero, Miguel Gavara, Ramón Torres-Cavanillas, Alicia Forment-Aliaga
ICMol-Universidad de Valencia, Catedrático José Beltrán 2, Paterna, Spain
Eugenio.coronado@uv.es

Abstract

Graphene and other 2D materials are almost exclusively based on inorganic lattices. Except for the chemical functionalization of the surface of the 2D material, molecules have been scarcely considered in this area. Here we will emphasize the role of functional molecular materials in this context. The molecular systems of choice are magnetic spin-crossover materials able to switch between two spin states upon the application of an external stimulus (temperature, light or pressure) [1]. This spin transition is always accompanied by a significant change of volume in the material (by ca. 10%), so it can generate strain in its surroundings. We propose to create hybrid heterostructures by interfacing this class of smart molecular materials ("exotic" for the 2D community) with graphene and semiconducting transition metal dichalcogenides (MoS_2 and WSe_2). The aim is that of tuning the properties of the "all surface" 2D material *via* an active control of the hybrid interface. This concept will provide an entire new class of smart molecular/2D heterostructures, which may be at the origin of a novel generation of hybrid materials and devices of direct application in highly topical fields like electronics, spintronics and straintronics. We will show that in these heterostructures the electronic properties of graphene and the optical photoluminescence of monolayers of WSe_2 can be switched by light or by varying the temperature due to the strain concomitant to the spin transition [2,3].

References

[1] E. Coronado. Nature Rev. Mater., 5 (2020) 87
[2] R. Torres-Cavanillas *et al.* Nature Chem. (2021**)** https://www.nature.com/articles/s41557-021-00795-y
[3] C.Boix *et al.* (2021) arXiv:2110.02990