Functionalization of 2D materials with bistable molecular systems: New modulable composites.

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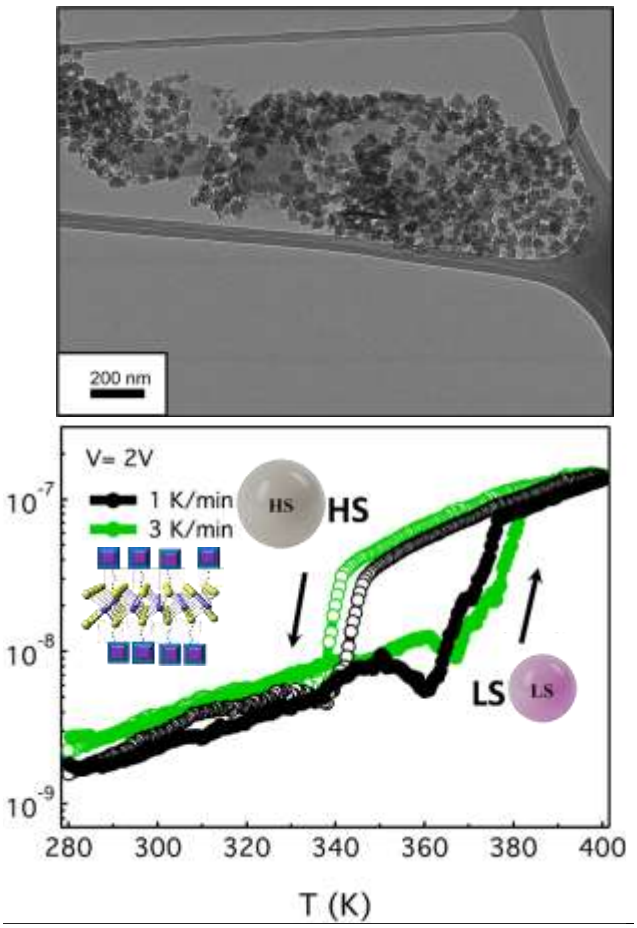
Among layered materials, transition metal dichalcogenides (TMDCs) of general formula MX_2 (M: transition metal, X: chalcogenide) have been deeply studied due to their broad spectrum of properties. Specially, the preparation of multifunctional composites based on molecular materials and TMDCs is a hot topic nowadays.[1] In this scenario we pursue the functionalization of TMDC layers with molecular systems that present bistability controlled by external stimuli. By this approach we want to tune the intrinsic electronic properties of the 2D material through the modulation of the molecular component. As prototypes we have functionalized MoS_2 layers with different spin crossover (SCO) systems. SCO compounds present a spin state transition (High spin, HS-Low spin, LS) under external stimuli like light, pressure or temperature. With this aim we have followed two different approaches: (1) the anchoring of SCO based nanoparticles (NPs)[2] onto MoS_2 flakes and (2) the growth of SCO ultrathin films of a Fe(II) Hofmann-type coordination polymer[3] on MoS_2 flakes. In this presentation we will focus on the former.

Our studies about the new MoS_2-SCO NPs composite point out that there is a clear modulation of the transport properties in the 2D layers when the spin transition of the attached SCO nanoparticles takes place (Figure 1). This could be related with a strain modulation induced by the change in volume of the NPs that comes along with the spin transition.

References

[1] S. Bertolazzi *et al., Chem. Soc. Rev. 47* (2018) 6845
[2] E. Coronado, E. *et al., Adv Mater, 19* (2007) 1359
[3] V. Rubio-Giménez *et al,*. Chem. Sci., DOI: 10.1039/C8SC04935A (2019)



Figures

Figure 1: TEM image of MoS_2 flakes functionalized with SCO nanoparticles (top) and transport properties (down) of this composite showing the change in conductivity with the spin transition of the nanoparticles.