Sensing switchable molecular systems with 2D materials

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Abstract

Graphene is one of the most studied materials due to its unique properties such as hardness, flexibility and high electric and thermal conductivity. [1] Probably, the best quality of graphene is that it has opened the field to many other 2D crystals [2] and, in particular, to molecular materials.

However, in the field of two-dimensional materials, molecular compounds are still scarce if compare with its inorganic counterparts and even more elusive are magnetic 2D molecular compounds. [3] Although less studied in the 2D-land, molecular systems exhibit new physical phenomenology like the so-called spin-crossover (SCO) transition. SCO materials are metal complexes where the spin state of the metallic center changes between high-spin (HS) and low-spin (LS) due to the presence of an external stimulus (light, pressure, temperature…), with potential applications as memory devices or in spintronic applications [4].

In this work, we fabricate hybrid molecular/inorganic van der Waals heterostructures based on molecular spin-crossover (SCO) materials and inorganic two-dimensional crystals (Figure 1). First, we exfoliate mechanically a SCO compound and characterize it by atomic force microscopy, optical microscopy and Raman spectroscopy. Then, these molecular flakes are deterministically combined with inorganic 2D systems like few-layers graphene (FLG) or atomically-thin layers of 2H-$NbSe_2$ and WSe_2, thus creating hybrid molecular/inorganic van der Waals heterostructures. Interestingly, the hysteretic thermal spin transition is detected by transport measurements in our hybrid van der Waals heterostructures.

Our results illustrate the synergy between SCO and inorganic 2D crystals and opens the door to explore further molecular compounds of interest which properties could not be detected otherwise.

REFERENCES

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FIGURES

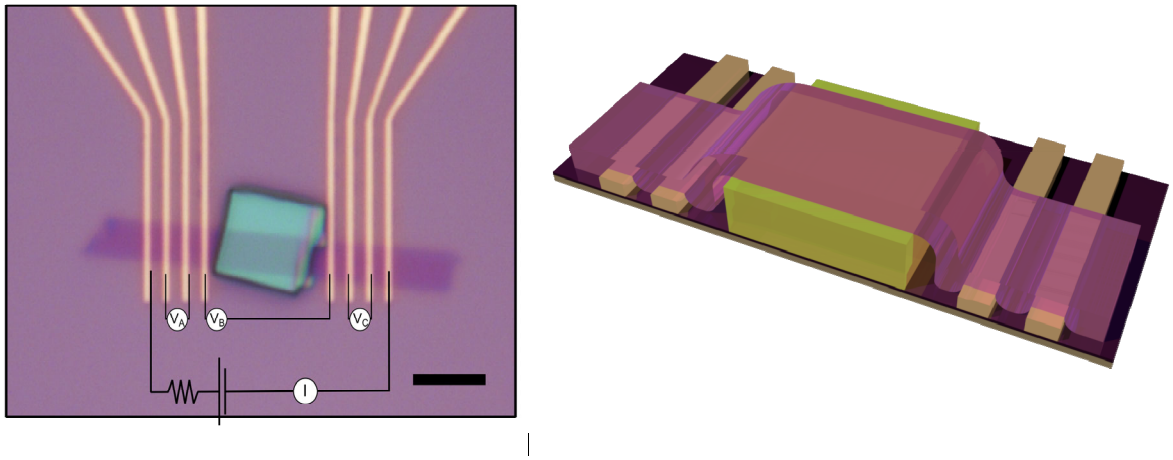

Figure 1: hybrid van der Waals heterostructure based on few-layers graphene and SCO crystals. Left: Device with the electronic transport configuration. Right: Artistic representation where the few-layers graphene is represented in purple, the SCO in yellow and the metal contacts in gold.