Tuning the properties of 2D magnets by twisting or by molecular strain

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The controlled assembly of 2D materials in van der Waals heterostructures provides the opportunity to design unconventional materials with novel properties. Here I will illustrate this concept through two examples:

1) A twisted 2D heterostructure formed by two ferromagnetic monolayers of CrSBr rotated by an angle of 90º [1]. Magneto-transport measurements in this new material show a multistep spin switching with the opening of hysteresis, which is absent in the pristine bilayer case (angle of 0º) [2], as a consequence of the competition between the inter-layer exchange interactions (which favor an antiparallel orientation of both spin layers) and the local spin anisotropy and an external magnetic field applied along the easy magnetic axis *b* (which tend to orient the spins along this easy axis).

2) A molecular/2D heterostructure obtained by interfacing a stimuli-responsive spin-crossover molecular system with CrSBr layers. We observe that in this hybrid heterostructure the properties of the 2D magnet changes when the molecular spin transition of this molecular component —induced by temperature or light— occurs. This is a consequence of the significant change generated in the volume of the spin crossover material (by ca. 10%) upon the spin transition [3, 4]. We will show that in this heterostructure the optical properties of CrCBr can be switched by varying the temperature, due to the strain concomitant to the spin transition.

References

[1] C. Boix-Constant *et al.* arXiv preprint arXiv:2301.05647
[2] C. Boix-Constant *et al.*, Adv. Mater., 34 (2022) 2204940
[3] C. Boix-Constant et al., Adv. Mater., 34 (2022) 2110027
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