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2D MOFs for Spin-Based Quantum Science

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Designing, understanding and exploiting quantum materials, such as magnets, superconductors and topological materials, is key in quantum science. These materials are contributing to develop solid-state platforms for quantum technologies in application areas as quantum sensing and quantum information technologies. Still, most of the materials so far investigated are based on reticular inorganic lattices. Here we will show that reticular metal-organic lattices can also be useful in this context.

In the first part layered magnetic MOFs of sufficient size and quality to be integrated in electronic devices are prepared using a solvent free approach, and mechanically exfoliated down to the monolayer. Thus, 2D magnetic crystals of formula $[M(bimX)_2]$ (M^{2+} = Fe, Co, Mn; HbimX = derivative of benzimidazole, with X = H, F, Cl, Br, CH_3 or NH_2) are obtained in which the magnetic anisotropy and exchange topology in the layers can be tuned by changing the metal or the ligand, while chemical functionalization guarantees the stability of the vdW layers [1]. Taking advantage of this chemical versatility, we have also been able to reduce the dimensionality of the magnetic network from 2D to 1D, while keeping the lattice dimensionality [2]. To do so we have crosslinked molecular magnetic chains with a bridging ligand that keeps them well-isolated in a layer structure. The integration of these 1D magnets into this 2D platform has facilitated the manipulation, control and exploitation of their magnetic and optical properties.

In the second part, 2D quantum materials (graphene, magnetic CrSBr, superconducting $NbSe_2$) are interfaced with a spin-crossover layered MOF, whose spin state can be switched thermally or by light [3]. Here a control over the properties of these 2D quantum materials has been obtained via the strain generated by the spin transition in the MOF .

References:

[1] J. Lopez-Cabrelles, S. Mañas-Valero *et al. J. Am. Chem. Soc.* 143, 18502 (2021).

[2] E. C. Mazarakioti, C. Boix *et al.*, Adv. Mater. 38 e17382 (2026).

[3] C. Boix *et al.*, Adv. Mater. e75351 (2026).