Towards electric-field gateable magnetism in 2D organic materials

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2D covalent organic frameworks (2D-COFs) are an emerging class of lightweight materials whose general structure is a 2D-network composed by nodal building block molecules bonded by linkers.[1] The use of organic radicals as nodal building blocks, which gives rise to so-called 2D covalent organic radical frameworks (2D-CORFs), adds functionality because the electron spin of the nodes opens the door to the realization of 2D organic materials with magnetic and spintronic properties.[2] We have recently demonstrated that modest out-of-plane compression [3] or in-plane strain [4] in 2D-CORFs can induce transitions between an antiferromagnetic Mott insulator ground state and either a semimetallic state or a closed-shell quinoidal state. This type of correlated electronic materials also provides a robust basis for 2D spin frustration upon partial chemical substitution of spin-carrying C centers by B or N [5], thus making 2D-CORFs appealing platforms for new 2D quantum materials able to host exotic magnetic states (e.g. spin liquid phases). Given the growing interest in the direct and efficient control of spin based magnetism through electric fields (E-fields) for new spintronic devices [6], in this contribution we will explore whether E-field modulation of the magnetic exchange coupling, *J*, between spin nodes is a promising strategy to control magnetism in 2D-CORFs. Building upon our previous experience in E-field actuated conformational molecular switches [7], we will consider 2D-CORFs made of aromatic dipolar linkers (see Figure 1) that can rotate in response to an E-field. Our first principles calculations show that the changes in π-conjugation of the 2D-CORFs upon E-field-induced rotation of the linkers result in significant changes in *J*'s using field strengths that are feasible with currently available setups. [8] Therefore, 2D-CORFs hold great potential as versatile platforms for E-field gateable magnetism in 2D organic materials.

[1] C. Wang, Z. Zhang, Y. Zhu, C. Yang, J. Wu, W. Hu. Adv. Mater., 2022, 34, 2102290
[2] I. Alcón, F. Viñes, I. d.P.R. Moreira, S.T. Bromley. Nat. Commun. 2017, 8, 1957
[3] R. Santiago, I. Alcón, J. Ribas, M. Deumal, I. d.P.R. Moreira, S.T. Bromley, Adv. Funct. Mater., 2021, 31, 2004584
[4] I. Alcón, R. Santiago, J. Ribas, M. Deumal, I. d.P.R. Moreira, S.T. Bromley, Nat. Commun., 2021, 12, 1705
[5] I. Alcón, J. Ribas, I. d.P.R. Moreira, S.T. Bromley, J. Am. Chem. Soc., 2023, 145, 5674
[6] X. Liang, et al. IEEE Transactions on Magnetics, 2021, 57, 400157
[7] K. Jutglar, R. Santiago, J. Ribas, S.T. Bromley, Phys. Chem. Chem. Phys., 2021, 23, 3844
[8] K. Jutglar, M. Deumal, J. Ribas, S.T. Bromley, submitted

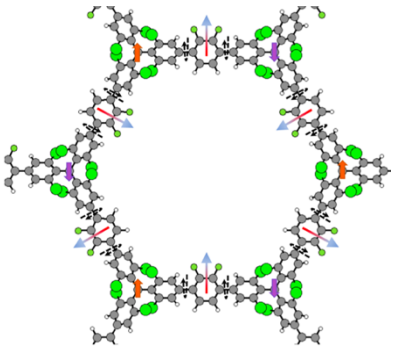

Figure 1: 2D-CORF made of triarylmethyl radicals bonded by difluorobenzene linkers