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Fabrication and Characterization of 2D Metal-Organic Network on Weakly Interacting 2D Materials

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Abstract:

The fabrication of atomically precise structures with designer electronic properties is currently being vigorously pursued within condensed-matter physics and materials chemistry research communities [1]. Over the past two decades, low-dimensional metal-organic networks (MONs) with various atomically precise lattice structures have been fabricated on coinage metal surfaces [2]. Recently, our group has synthesized and characterized several two-dimensional (2D) MONs on the weakly interacting substrates under ultra-high vacuum (UHV) conditions using low-temperature scanning tunnelling microscopy (STM) and spectroscopy (STS) [3-5]. We demonstrate a successful synthesis of a large-scale monolayer Cu-dicyanoanthracene (DCA) network that can grow across the terrace of an epitaxial graphene surface [4]. The ordered DCA_3Cu_2 network shows a structure combining a honeycomb lattice of Cu atoms with a kagome lattice of DCA molecules. Combing the STM/STS data with density-functional theory (DFT) results, we confirm that a kagome band structure is formed in the 2D MON near the Fermi level. We demonstrate access to multiple molecular charge states in the 2D MON using tip-induced local electric fields, which highlights the role of electron-electron interactions that are likely to give rise to exotic electronic properties. Furthermore, to realize the exciting prospect of truly designer materials, it is important to demonstrate MOF synthesis on other 2D substrates. Here, I will also discuss our recent efforts of synthesizing metal-organic network on $NbSe_2$, which extends the synthesis and electronic tuneability of 2D MOFs beyond the electronically less relevant metal and semiconducting surfaces to superconducting substrate [5]. We expect that a similar strategy can be applied to the development of emerging quantum materials.

References:

[1] L. Yan and P. Liljeroth. Adv. Phys. X. 4, 1651672 (2019).

[2] L. Dong, Z. Gao, and N. Lin. Prog. Surf. Sci. 91, 101 (2016).

[3] A. Kumar, K. Banerjee, A. Foster, and P. Liljeroth. Nano Lett. 18, 5596 (2018).

[4] L. Yan, et al. Adv. Funct. Mater. 31, 2100519 (2021).

[5] L. Yan, et al. unpublished result (2021).