Electrically Conductive Two-Dimensional Metal-Organic Frameworks

Dr. Renhao Dong,
Chongqing Yang, Mingchao Wang, Zhiyong Wang, Dr. Haixia Zhong, Prof. Dr. Xinliang Feng

Department of Chemistry and Food Chemistry & Center for Advancing Electronics Dresden, Technische Universität Dresden, 01062 Dresden, Germany

Renhao.dong@tu-dresden.de

The traditional 3D metal-organic frameworks (MOFs) are considered as insulators due to the insulating organic ligands, which are rarely applied in organic electronics. However, the recently rising π-conjugated two-dimensional metal-organic frameworks (2D MOFs) have emerged as highly appealing electronic materials[1] for energy storage and conversion,[2] and field-effect transistors,[3] owing to their high electrical conductivity and tuned band gaps. In our work, we have demonstrated the "bottom-up" synthesis of a series of π-conjugated 2D MOFs based on metal-bis(dithiolene)/-bis(diimino)/-catecholate complexes via interfacial synthesis[4] and one-pot solvothermal synthesis, which exhibit high DC conductivity. For instance, the achieved hexathioltriphenylene-fused iron-bis(dithiolene) 2D MOF film ($Fe_2(HTT)_3$) by interfacial synthesis firstly shows *n*-type semiconducting behavior with small band gap of 0.6 eV and electron mobility of ~2 cm^2/Vs at 298 K via Hall effect measurements. Moreover, for the first time, we demonstrate the room temperature band-like transport in such 2D MOFs by time-resolved terahertz pulse spectroscopy. A Drude model is applied to perfectly fit the alternating current (AC) transport and presents that the charge mobility could reach as high as ~150 cm^2/Vs. Given the promising conductivity as well as their intrinsic porous structures, we explored the functions of these π-conjugated 2D MOFs in Li-ion batteries, micro-supercapacitors, electrocatalysis, chemiresistive sensing and spintronics.

References

[1] Sun, L.; Campbell, M.G. & Dincă, M., Angew. Chem. Int. Ed., 55 (2016)3566-3579.
[2] Sheberla, D.; Bachman, J.; Elias, J.; Sun, C.; Shao-Horn, Y. & Dincă, M. Nat. Mater., 16 (2016) 220.
[3] Wu, G.; Huang, J.; Zang, J.; Jun He, J. & Xu, G. J. Am. Chem. Soc., 139 (2017) 1360-1363.
[4] Dong, R.; Pfeffermann, M.; Liang, H.; Zheng, Z.; Zhu, X.; Zhang, J. & Feng, X. Angew. Chem. Int. Ed., 54 (2015) 12058-12063.

Figures

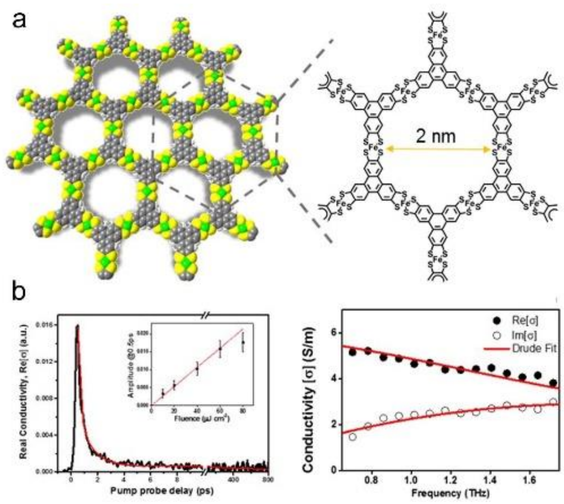

Figure 1: (a) Structural schematics of $Fe_2(HTT)_3$ 2D MOF. (b) Room temperature photoconductivity of $Fe_2(HTT)_3$ measured by THz spectroscopy.