Surprising Properties of 2D Metal-Organic Frameworks

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Abstract

The emergence of electrically conductive metal-organic frameworks (MOFs) has been one of the most paradoxical developments in the field in the last few years. Indeed, how can one transport charges through a material that is mostly "empty" space? In this sense, MOFs made from layers of organic ligands connected by (typically) square-planar metal ions have shown particularly good electrical conductivity. However, a precise mechanism for charge transport is still the subject of debate, with various experimental and computational reports describing these materials as metals, semiconductors, semimetals, or even borderline insulators. Most of the discussion on this point has been focused on the effects of in-plane metal-ligand conjugation and the efficiency of in-plane transport.

This lecture will describe the latest efforts from our group to understand the intrinsic properties of these materials, especially as related to single-crystal electrical measurement studies, and will discuss in particular the unexpectedly large influence of out-of-plane transport. Time allowing, I will discuss unexpected results stemming from the behavior of these materials as 1D metals, and applications in energy storage and conversion.

Biography

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Mircea Dincă was born in Făgăraş, a small Transylvanian town in central Romania. He obtained his Bachelor of Arts degree in Chemistry from Princeton University in 2003, and did his graduate work at UC Berkeley, where he obtained a PhD in Inorganic Chemistry in 2008. After a two-year stint as a postdoctoral associate working on heterogeneous electrocatalytic water splitting at MIT, he became an Assistant Professor in the Department of Chemistry at MIT in July 2010. Promoted to Associate Professor in 2015 and to Professor of Chemistry in 2020, he currently holds the W. M. Keck Chair as Professor of Energy at MIT. His research interests focus on creating and manipulating microporous and low-dimensional solids with molecular precision for applications in various energy efficiency and environmental challenges. These include, but are not limited to: electrical energy storage and conversion, heterogeneous catalysis, fresh water harvesting, efficient air conditioning, and photophysical processes. He has been named to the world's most cited Chemists list since 2014 and has received a number of awards, most recently the Alan T. Waterman Award, NSF's most prestigious award in all sciences and engineering for researchers under 42 (2016), the ACS Award in Pure Chemistry (2018), and the Blavatnik Award in Chemistry (2021).

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