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2pm (Ingram Lecture
Theatre)

Mircea
Dincă (MIT)

Catalysis and Charge Transport in
Microporous Metal-Organic
Frameworks

Teaching Sponges New Tricks:

Catalysis and Charge Transport in Microporous Metal-Organic Frameworks

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Short Bio

Mircea Dincă was born in 1980 in Făgăraș, a small Transylvanian town in central Romania. He obtained his Bachelor of Arts degree in Chemistry from Princeton University in 2003, where he did undergraduate research with Prof. Jeff Schwartz. He did his graduate work at UC Berkeley, where he obtained a PhD in Inorganic Chemistry in 2008. At Berkeley, he worked on the synthesis and characterization of microporous metal-organic frameworks for hydrogen storage and catalysis under the supervision of Prof. Jeffrey R. Long. After a two-year stint as a postdoctoral associate working on heterogeneous electrocatalytic water splitting with Prof. Daniel G. Nocera at MIT, he became an Assistant Professor in the Department of Chemistry at MIT in July 2010. For his research on microporous materials with applications in energy storage, conversion, and heterogeneous catalysis, he was awarded the US Department of Energy Young Investigator Award in 2011, the 3M Non-Tenured Faculty Grant in 2013, the Sloan Fellowship and Cottrell Award in 2014, and the NSF CAREER Award, the ACS ExxonMobil Solid State Chemistry Fellowship, and Dream Chemistry Award (Polish Academy of Science) in 2015. He holds patents in advanced cooling technologies involving adsorption heat pumps, in heterogeneous catalysis for ethylene upgrading, and in electrodeposition techniques for porous membranes, along with the discovery of porous, highly conductive materials. Dincă was promoted to Associate Professor in the Department of Chemistry at MIT in 2015.



Abstract

Traditional applications of metal-organic frameworks (MOFs) are focused on gas storage and separation, which take advantage of the inherent porosity and high surface area of these materials. The MOFs' use in technologies that require charge transport have lagged behind, however, because MOFs are poor conductors of electricity. We show that design principles honed from decades of previous research in molecular conductors can be employed to produce MOFs with remarkable charge mobility and conductivity values that rival or surpass those of common organic semiconductors and even graphite. We further show that these, ordered, and crystalline conductors can be used for a variety of applications in energy storage, electrocatalysis, electrochromics, and selective chemiresistive sensing. Another virtually untapped area of MOF chemistry is related to their potential to mediate redox reactivity and heterogeneous catalysis through their metal nodes. We show that MOFs can be thought of as unique macromolecular ligands that give rise to unusual molecular clusters where small molecules can react in a matrix-like environment, akin to the metal binding pockets of metalloproteins. By employing a mild, highly modular synthetic method and a suite of spectroscopic techniques, we show that redox reactivity at MOF nodes can lead to the isolation and characterization of highly unstable intermediates relevant to biological and industrial catalysis, and to industrially relevant catalytic transformations that are currently performed only by homogeneous catalysts.