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Catalysis and Charge Transport in Microporous Metal-Organic Frameworks

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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 expect that such high surface area, ordered, and crystalline conductors will 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.

主催:九州大学 最先端有機光エレクトロニクス研究センター

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