Visible-Light-Responsive MOF Catalysts for Hydrogen Production from Hydrogen Carrier Molecules

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Metal-organic frameworks (MOFs) are comprised of inorganic metal ions as connecting centers and organic moieties as linkers. Such inorganic-organic polymers offer significant chemical diversity because they can be modified by functional groups and, therefore, they have been widely employed in many applications such as catalysis, gas sorption, energy storage, and membrane [1−5]. It is clear that MOFs provide a great opportunity for constructing hybrid materials due to the richness of metal-containing center and organic bridging linker, as well as the controllability of the synthesis. MOFs have the following advantages: (i) structural features of MOFs, such as the diameter of the cavity and the size of the pore can be easily controlled by changing the organic ligand with different length and the unique chemical environments at the nodes can be easily modified by functionalization of metal cluster of MOFs; (ii) efficient solar light harvesting, the photo-reactive MOFs can absorb the solar light and convert the solar light to chemical energy, moreover, the optical properties of MOFs can be easily tailored from UV region to visible light region via the linker substitutions with the great amount of organic chromophore in MOFs structures; (iii) applicable to versatile redox reactions, the significant chemical diversity allows a great amount of semiconductor and different kinds of metal nanoparticles supported on MOFs; (iv) extremely short charge transportation pathway, the atomic-level crystal structures of MOFs significantly reduce the distance of charge transportation pathway to active sites.

Here, we have developed some synthetic protocols to synthesize hybrid MOFs catalysts to boost catalytic activities of hydrogen (H_2) production from hydrogen carrier molecules. Several photocatalysts have been synthesized by supporting different kind of metal nanoparticles on MOFs and investigated their application to catalyze H_2 production from hydrogen carrier molecules, such as water splitting, H_2 production from formic acid and ammonia borane by utilizing solar energy (Fig. 1). Very impressive results have been obtained. The enhanced activities of those hybrid materials can be ascribed to that the charges generated upon irradiating visible light on MOFs can migrate to catalytic active sites (metal nanoparticles) to be used for promoting the catalytic activity of redox reactions. The possible mechanism of synergistic effect between MOFs and supported metal nanoparticles on the enhancement photocatalytic performance was elucidated. This study supplies a platform to design other hybrid MOFs catalysts for efficient catalytic reactions under various light environments.

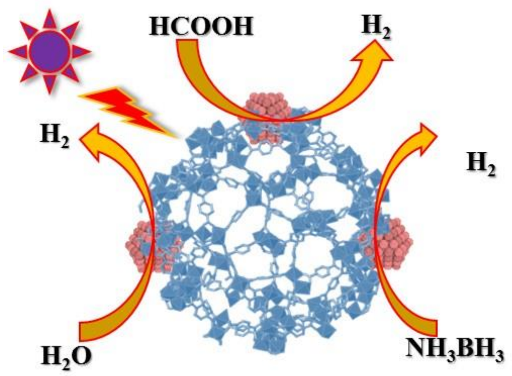

Fig. 1 Design of metal nanoparticle loaded MOFs for visible-light-enhanced H_2 production from hydrogen storage materials.

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