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Metal-Organic Frameworks as Heterogeneous Catalysts in Hydrogen Production from Lightweight Inorganic Hydrides

Rossin A., Tuci G., Luconi L., Giambastiani G.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2017 American Chemical Society. Ammonia-borane (NH 3 ·BH 3 , AB), hydrazine (NH 2 NH 2), lithium borohydride (Li(BH 4)), and sodium alanate (Na(AlH 4)) are popular chemical hydrogen storage inorganic solid materials featuring high gravimetric hydrogen contents (H wt %) and remarkable stability under ambient conditions. Ultrapure H 2 is formed from these compounds either via pyrolysis (i.e., a simple material heating) or via hydrolysis (chemical reaction with water). In both cases, a series of homogeneous and heterogeneous catalysts have been designed to assist the process. Among the latter, metal-organic frameworks (MOFs, crystalline 3D porous lattices made of metallic nodes and organic polytopic linkers) have rapidly emerged as versatile candidates for this role. The nanoconfinement of lightweight hydrides in MOFs produces a "hydride@MOF" composite material. Hydride coordination to MOF exposed metal sites or its reaction with functional groups on the organic linkers facilitates the thermal decomposition, lowering the hydrogen release temperature and increasing the hydrogen production rate. For hydrolysis, MOFs are used as templates for the preparation of metal(0) nanoparticles (NPs) uniformly distributed in their inner cavities through a preliminary impregnation with a solution containing a metal salt followed by reduction. The "NPs@MOF" are the real active species that catalyze the reaction between the hydride and water, with concomitant H 2 evolution. This perspective highlights the most representative literature examples of MOFs as heterogeneous catalysts (or catalyst supports) for H 2 production from inorganic lightweight hydrides. Future trends in the field will also be discussed. (Figure Presented).

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Keywords

alanates, ammonia-borane, borohydrides, hydrazine, hydrogen, metal-organic frameworks

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