Copper-Based Metal–Organic Framework: Synthesis, Characterization and Evaluation for the Hydrogenation of Furfural to Furfuryl Alcohol

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Abstract

A novel Cu-MOF was synthesized at room temperature from commercially available and inexpensive reagents. The pre-catalyst was characterized using X-ray photoelectron spectroscopy, high-resolution transmission electron microscopy, inductively coupled plasma-optical emission spectroscopy, Fourier transform-infrared spectroscopy, powder X-ray diffraction, Brunauer-Emmet-Teller (BET) and scanning electron microscopy-energy dispersive X-ray spectroscopy. The Cu-MOF was characterized as microporous material with BET surface area and pore volume of 7.47 m2/g and 0.27 cm3/g, respectively, and is stable in most solvents. The MOF was evaluated as a heterogeneous catalyst for the hydrogenation of furfural to furfuryl alcohol (FA). Cu-MOF exhibited a high conversion of FF (76%) with selectivity towards FA (100%) at 140 °C, 50 bar for 24 h. The MOF was reused four consecutive times with a loss in catalytic performance. The decrease in catalytic activity could be attributed to the formation of inactive Cu(0) as revealed by HR-TEM and XPS studies. The HR-TEM of spent Cu-MOF showed a uniform particle size diameter of 3.5 nm. This work is significant in providing new strategies for the design and fabrication of highly selective MOF catalysts for the FF upgrading.

Keywords: Metal–organic framework, Heterogeneous catalyst, Furfural upgrading, Furfuryl alcohol