IMPACT OF METAL SUBSTITUTION ON STABILITY AND ADSORPTION PROPERTIES OF MOF-74

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Varying amounts of Co and Ni were substituted into the metal-organic framework Mg-MOF-74 via a one-pot solvothermal reaction, and the effects of these substitutions on CO$_2$ adsorption and kinetic water stability properties were examined. Based on elemental analyses, Co and Ni are more favorably incorporated into the MOF-74 framework from solution than Mg. In addition, reaction temperature more strongly impacts the final metal composition in these mixed-metal (MM) MOF-74 structures than does the reaction solvent composition. Single-component CO$_2$ adsorption isotherms were measured for the MM-MOF-74 systems at 5, 25 and 45 °C and isosteric heats of adsorption were calculated. These results suggest that CO$_2$ sorption properties can be adjusted by partial metal substitution. Water adsorption isotherms were also measured for the MM-MOF-74 samples, with powder X-ray diffraction patterns and Brunauer-Emmett-Teller surface areas measured both before and after water exposure. Results show that Mg-MOF-74 can gain partial kinetic water stability by the incorporation of Ni$^{2+}$ or Co$^{2+}$ metal ions that are less vulnerable to hydrolysis than Mg$^{2+}$. Of particular note, Mg-Ni-MM-MOF-74 shows a significant increase in water stability when incorporating as little as 16 mol% Ni into the Mg-MOF-74 structure.

Reference: