Bioinspired CO2 Capture: Mimicking Carbonic Anhydrase With a Zn(II) Histidine Metal Organic Framework

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Demand for energy to power industrial processes continues to increase in modern society, leading to increased carbon dioxide emissions into the atmosphere as a byproduct of burning fossil fuels and subsequent climate change phenomena. The enzyme carbonic anhydrase (CA) has an incredibly high catalytic efficiency in the conversion of carbon dioxide into bicarbonate, giving it potential as an environmentally friendly material for carbon dioxide capture. However, its sensitivity to pH and high temperatures prevents practical applications. The objective of this study is the synthesis and characterization of a novel metal-organic framework (MOF)-[Zn(HIS)] (HIS = histidine) to mimic the catalytic functions of CA. The crystal structure of the MOF was determined with single crystal x-ray diffraction data, and the stability of the MOF in basic solutions was tested using powder x-ray diffraction to compare the structural integrity of compound before and after soaking in alkaline conditions. The biomimetic ability was analyzed through spectrophotometric data on the rate of the p-nitrophenylacetate model reaction with the MOF being used as the catalyst. The MOF seemed to increase the rate of reaction slightly at 10mg, but not significantly at any other proportions. The MOF was determined to have Zn(II) ions with a distorted tetrahedral and distorted trigonal bipyramidal geometry coordinating to three histidine ligands, as well as being stable in basic conditions across 2 and 4 hours.

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