Metal Organic Frameworks and Their Derived Products for Carbon Dioxide Capture

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ABSTRACT

Climate change has been notably affecting our planet since early 20th century, and there is evident showing that continuously increasing global temperature has strong correlation with increasing carbon dioxide concentration. Efforts have been made to reduce the atmosphere carbon dioxides amount by capturing/storing them using various approaches. Among solid adsorbents, Metal organic frameworks (MOFs) are a promising class of porous materials that attracted lots of recent attention as an ideal platform for the development of next generation CO_2 capture materials owing to their large capacity for the adsorption of gases and their structural and chemical tunability both during and post synthesis. Other applications for MOFs also cover a range of gas storage, molecular separations, heterogeneous catalysis, and drug delivery.

Furthermore, MOFs themselves can be used not only for adsorption directly, but also as a kind of template for the creation of other nanostructured materials for a wide variety of applications. Specifically, in this study, a magnesium based MOF was first synthesized then used as a precursor for generation of magnesium oxide. The generated magnesium oxide was then tested for its cyclic carbon capture performance. Results showed that by tuning the synthesis conditions (such as

calcination temperature and heating rate) as well as operating conditions (such as adsorption and desorption temperature), a regenerable magnesium oxide with competitive CO_2 capacity was successfully obtained, which at some degree solve the challenges of metal oxide for CO_2 capture. More work needs to done to explore the full carbon capture potential along with the adsorption mechanism of this material.

Other purposes of this research were also proposed. One of them is synthesis of three-dimensionally mesoporous (3DOm) zeolitic imidazolate frameworks (ZIFs) in prous carbon. The experimental plan was proposed by combining the synthesis of 3DOm zeoolites with the synthesis of ZIFs. Potential applications for obtained 3DOm ZIFs such as serving as metal oxide precusor or selective phase in membrane fabricating will be disscussed. Another goal of this work will be focused on usinsg there MOFs or end products to synthesis mixed matrix membranes (MMMs). Obtained magnesium oxide and 3DOm ZIFs that will be synthesized in the future are chosen as the inorganic particles to integrate with polymer membranes for CO_2 separation application. Separation performance like permeability and selectivity of binary gas mixtures of CO_2/N_2 and CO_2/CH_4 will be potentially tested on MMMs.