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CO_2 Adsorption on Hierarchical Electrospun Carbon Nanofiber Aerogels Doped With In Situ Grown ZIF-8 Derived Carbon

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Extended Abstract

In order to achieve the targets of net zero emissions, the development of CO_2 capture and storage (CCS) technologies is very important in the transition from fossil fuels to clean energies, except for the carbon reduction in fuels. The porous materials are believed to be promising materials for CO_2 capture. Recently, the applications of zeolitic imidazolate framework-8 (ZIF-8) on CO_2 capture have attracted increasing interest [1]. However, the ZIF-8 nanoparticles are easily aggregated to make the operations difficult and get poor cyclic operation performance. If ZIF-8 nanoparticles are combined with carbon nanofibers to form composite materials, this issue should be solved [2]. Moreover, in order to improve the inconvenience of nanopowders in industrial applications, fabrication of functional aerogels should be an attempt [3]. In this study, ZIF-8 crystals were prepared using in-situ growth method on polyacrylonitrile (PAN) carbon nanofibers, tuning the pore structure and the surface chemistry, to fabricate the Zn@C/PAN nanocomposites by means of electrospinning, hydrothermal reaction, aerogel technology and carbonization processes. Three different precursors of Zn were selected to determine the effects on CO_2 uptakes. Results show that the Zn ions escaped from the electrospun fibers during the hydrothermal reactions, reacted with 2-MeIM and formed ZIF-8 crystals on the surface of fibers. Moreover, 2-MeIM could penetrate into the fibers from the intrinsic porosity or from the channels due to the polyvinyl pyrrolidone (PVP) leaching to form ZIF-8 inside. In addition, Zn atoms might evaporate at the high temperature carbonization process, resulting in obvious pores at the nodes on the fibers. Different Zn precursors does not affect the elemental compositions on the products. Nevertheless, the microporosity, surface chemistry and the CO_2 adsorption capacities of the Zn@C/PAN nanocomposites were dependent on the Zn precursors. The highest CO_2 adsorption capacities at 25 ^oC were observed on Zn2@C/PAN, 1.22 and 2.97 mmol/g at 0.15 and 1 atm, respectively. The CO_2 adsorption capacities of Zn@C/PAN nanocomposites could increase 16 % of that on pure PAN aerogel. This could be attributed to the pore volume, the nitrogen content and the Zn content. The CO_2 adsorption isotherms could be fitted well by Freundlich equations. The isosteric heat of adsorption implied that the CO_2 adsorption on Zn@C/PAN aerogel samples were the synergic effects of physical and chemical adsorptions.

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