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Preparation and CO_2 adsorption properties of porous carbon from camphor leaves by hydrothermal carbonization and sequential potassium hydroxide activation

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In this work, porous carbon was prepared from camphor leaves (CLs) by hydrothermal carbonization (HTC) and sequential potassium hydroxide activation. The morphology, porous structure, chemical properties, and CO_2 capture capacity of the produced materials were investigated. The influence of HTC temperature on the material structure and capture capacity was studied. HTC temperature was found to have a major effect on the structure of the products and their CO_2 capture capacity. The porous carbon obtained under HTC temperature of 240 °C exhibits a high ratio of microporosity, a large specific surface area (up to 1633.71 $m^2\ g^{-1}$) and a maximum CO_2 adsorption capacity of 6.63 mmol g^{-1} at 25 °C under 0.4 MPa. The Langmuir isotherm model depicts the equilibrium data much better than the Freundlich isotherm model. The pseudo-first-order kinetic model describes the kinetic data better than the pseudo-second-order kinetic model. Our results demonstrate that the porous adsorbents prepared from CLs provide a feasible option for CO_2 capture with low cost, environmental friendship and high capture capability.

1. Introduction

Recently, serious environmental problems are gaining more and more attention globally, in particular the issue of global warming. The carbon dioxide (CO_2) as a major anthropogenic greenhouse gas has been increasingly released which needs to be addressed ascribe to its detrimental effect on the global warming issues. Carbon capture and storage technology is a potential option to solve this problem. Currently, capturing CO_2 using various porous materials has attracted increasing attention, including materials such as zeolites, mesoporous silica, metal–organic frameworks, molecular sieves and porous carbon, because of their abundant pore structures and high surface area.[1–4] Among these materials, porous carbons have the greatest potential for application because they are derived from a large variety of low-cost resources and have a highly developed porous structure, abundant functional groups, hydrophobicity and high availability.[5–7]

Porous carbons are often derived from various biomasses by thermal pyrolysis, chemical activation or hydrothermal carbonization (HTC), followed by carbonization or chemical activation. Zhu *et al.*[8] investigated the characteristics and tetracycline adsorption behaviour of a novel porous carbon prepared using HTC. High activation temperatures ranging from 300 to 700 °C were found to work well for hydrochar carbonization and the produced materials exhibited high surface areas (>270 $m^2\ g^{-1}$). Wang *et al.*[9] obtained development activated carbon materials with a high specific surface area (over 3000 $m^2\ g^{-1}$) and large pore volume (over 2 $cm^3\ g^{-1}$) using potassium hydroxide (KOH) activation of fossil-based materials. Parshetti *et al.*[10] obtained low-cost carbonaceous adsorbents with a remarkable carbon dioxide uptake capacity (3.71 mmol g^{-1}) from empty palm fruit bunch feedstock using HTC and chemical activation. Zhan *et al.*[11] successfully synthesized composite graphene-based mesoporous silica sheets to serve as an efficient carrier support for polyethyleneimine *via* a nano-casting technology, which exhibited a high adsorption capacity of 190 mg g^{-1} and good cycle stability for CO_2 capture.

An enormous range of biomass materials has been used for activated carbon precursors, including palm seed,[12] rice husk,[13] corn cobs,[14] fruit stone,[15,16] date stone,[17] tomato-peel,[18] cellulose,[19] *Eucalyptus camaldulensis* wood,[20] cotton stalk,[21] and oak leaf.[22] Among these waste biomass materials, leaves are a sustainable resource which do not require the destruction of trees. The camphor tree has leaves all year and is the "city tree" of Shanghai. This tree is widely planted in Shanghai, as well as in many other cities. We can obtain camphor leaves (CLs) anytime, either by picking fresh leaves from the tree or

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