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Excellent performance of porous carbon from urea-assisted hydrochar of orange peel for toluene and iodine adsorption

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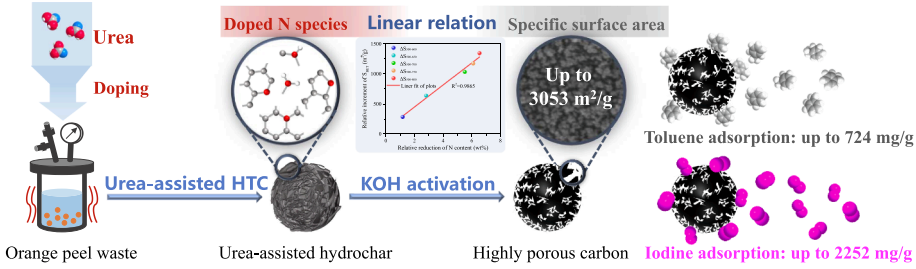
HIGHLIGHTS

- Highly porous carbon was obtained by activation of urea-assisted hydrochar.
- Highly porous carbon possessed ultra-high surface area up to 3053 m^2/g.
- N-containing groups involving activation of hydrochar facilitated the porosity.
- Good liner relation of between variations of surface area and N content was found.
- Highly porous carbon showed excellent capacities for toluene and iodine adsorption.

GRAPHICAL ABSTRACT



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ABSTRACT

In order to promote the physicochemical properties and the pollutants adsorption capacities of porous carbon, a novel urea-assisted hydrothermal method was developed to produce N-doped hydrochar as an ideal precursor from orange peel waste. Different from the modification technologies for nitrogen doping, the highly porous carbon prepared by KOH activation of the urea-assisted hydrochar contained extremely low N content. But such sample showed ultra-high specific surface area up to 3053 m^2/g, with 63% and 39% higher than the porous carbons through conventional N-free method and hydrochar-urea mixing activation method respectively. In-depth study revealed that during 600–800 °C activation procedure, the N-containing groups including pyridinic-N, pyridonic-N and graphitic-N in the urea-assisted hydrochar reacted sufficiently with K_2CO_3, an intermediate of KOH activation, and generated NH_3, creating richer porous structures in carbon. Particularly, there was a good linear relationship between the relative increment of specific surface area and the relative reduction of N content in porous carbon when the activation temperature increasing. This connection can be served as a reference to increase the porosity of porous carbon through the activation of N-doped carbonaceous precursor. As for pollutants adsorption, the highly porous carbon from urea-assisted hydrochar possessed excellent toluene adsorption capacity up to 724 mg/g and iodine adsorption capacity up to 2252 mg/g.

1. Introduction

Porous carbon materials have shown great potentials for pollution control in air and water environment, due to their large surface area, structure tenability and excellent thermal stability [1–3]. Generally, the high cost of porous carbon is one of the major challenges for its commercial applications [4]. Therefore, organic solid waste with rich carbon and low inorganic contents (e.g. fruit peel and coconut shell)

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