

물리화학적 활성화법이 다공성 탄소의 기공발현에 미치는 영향

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Effect of Physical/Chemical Activation on the Porosity Evolution of Porous Carbons

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1. Introduction

Porous carbons have been used as adsorbents, filters, catalyst supports, etc. due to well-development pore structure. Porous carbons can be prepared by two different activation processes i.e. physical activation by steam or CO₂, and chemical activation by KOH, H₃PO₄ etc. from various raw material. Recently, agricultural wastes such as rice hulls [1], coconut shell [2-3] and straws [4] are growing interest as precursors for porous carbons due to its easy availability and cheapness.

In this study, rice straws were chosen as precursor to prepare porous carbons because they have a fine developed structure and special porous structure inborn. Activation was carried out by physical with CO₂ and chemical activation with KOH. And porosity development and surface morphologies of two different types of porous carbons were examined in terms with activation temperature and chemical ratio.

2. Experimentals

In the both case of physical and chemical activation, the dried rice straws (DR) were subjected to the two different heat-treatment histories, i.e. the one- and two-stage processes. In the case of physical activation, DR was activated at 700-900 °C under CO₂

(denoted as one-stage process) and also DR was carbonized at 900°C, followed by activation at 700-900°C under CO₂ (denoted as two-stage process). In the case of chemical activation, DR impregnated with KOH was heat-treated at 500-900°C under N₂ (denoted as one-stage process) and also DR was carbonized under N₂, followed by impregnation with KOH and activation at 600-900°C (denoted as one-stage process).

Porosity evolution of porous carbons was monitored by nitrogen adsorption/desorption isotherms at 77K on an automatic adsorption instrument (ASAP 2010, Micromeritics, USA) in the relative pressure ranging from 10⁻³ to 1. The surface morphological change was investigated with JSM-T200 Scanning Electron Microscope (JEOL, Japan), operating at 25 kV. Wide angle X-ray diffractometry (XRD) spectra were recorded on a MXP 18X-MF22-SRA diffractometer (MAC/Science, Japan), using Ni-filtered Cu K α radiation ($\lambda = 1.5418 \text{ \AA}$).

3. Results and Discussion

Figure 1 shows BET surface area of various porous carbons obtained by physical and chemical activation. In the case of physical activation, the heat treatment at 800°C for 3hrs was the optimum activation condition within the experimental range. This could be attributed to the fact that, although pore-drilling and pore-widening occur simultaneously to increase the micro and mesopore volumes to the activation temperature of 800°C, pore-widening effect was however dominant above 800°C, leading to the increase of mesopore volume. In the case of chemical activation, porous carbon obtained at 900°C by the two-stage process did exhibit the highest surface area of 2410 m²/g.

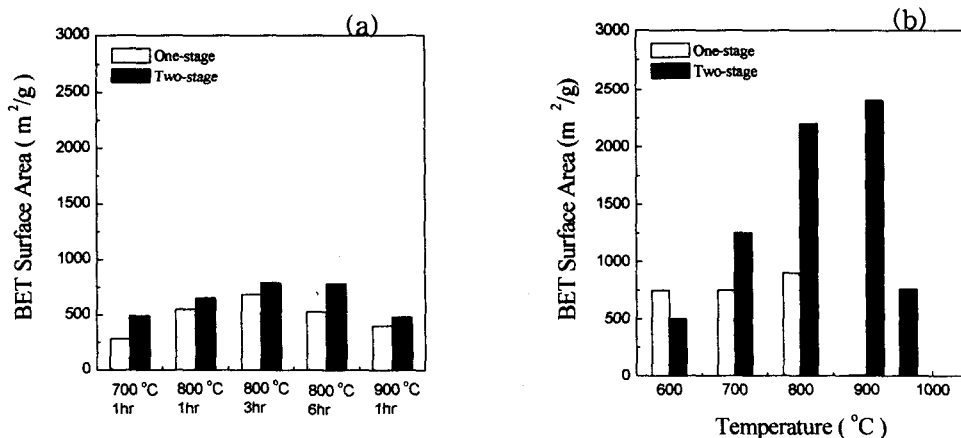


Figure 1. BET surface area of (a) physical and (b) chemical activated carbons.

It is worth to note that when the pre-carbonization was included prior to activation, higher surface area of both kinds of porous carbons (by physical and chemical activation) was obtained. Moreover, it was found that there is a preferential optimum impregnation ratio of KOH to a precursor carbon, i.e. 4:1, with which high surface area of porous carbons can be achieved.

It was found that the inclusion of pre-carbonization process contributes to the formation of porous carbons with higher values of the BET surface area than those of activated carbons without pre-carbonization in both physical and chemical activation. From this observation, it can be concluded that the inclusion of pre-carbonization process is necessary to get a relatively less defective carbonaceous intermediate that yields high content of micropores during the subsequent activation of rice straws.

4. Reference

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