

EVALUATION OF MICROPORE ANALYSIS METHODS USING NITROGEN ADSORPTION ISOTHERMS FOR MODEL POROUS CARBONS

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Introduction

Because of their remarkable sorption properties, active carbons are commonly used in purification of liquids and gases, separation of mixtures and catalysis (1, 2). A characteristic structural feature of active carbons is the presence of a significant amount of micropores (width below 2 nm), which are responsible for high surface areas and sorption capacities (1-3) of these materials. Active carbons are usually obtained by carbonization and activation of various precursors of natural origin (1, 2). More recently, synthetic carbonaceous precursors, such as phenolic (4) or styrene-divinylbenzene (5, 6) resins, have been used and the resulting active carbons were reported to have improved sorption (5) and mechanical (6) properties.

In the current study, active carbons obtained by controlled carbonization of ion-exchange resins were used to examine adsorption methods of micropore analysis.

Experimental

The synthetic active carbons studied in the current work were obtained by controlled carbonization of ion-exchange resin precursors at Supelco, Inc. A nongraphitized carbon black, BP 280, was acquired from Cabot Co. and was used as the reference solid based on data from previous work (7).

Adsorption measurements were performed on an ASAP 2010 volumetric adsorption apparatus from Micromeritics (Norcross, GA). Before the measurements, the samples were degassed for 2 h at 473 K. The BET specific surface area S_{BET} (8) was calculated from the data in a relative pressure range from 0.04 to 0.1. The total pore volume V_t was calculated by converting the amount adsorbed at a relative pressure ca. 0.99 to the corresponding volume of the liquid adsorbate. The external surface area S_{ex} and micropore volume V_{mi} were calculated from the α_s -plot method (8-11). The pore volume distribution (PSD) was calculated using the DFT software from Micromeritics (12).

Results and Discussion

Shown in Figures 1 and 2 are nitrogen adsorption

isotherms for selected samples under study. It can be noticed that although the course of low pressure adsorption for the active carbons is very similar, the samples differ in their high pressure adsorption properties. Such a behavior suggests that the carbons under study have similar microporous structures and variable amount of mesopores and macropores. Listed in Table 1 are structural parameters for the samples. The active carbons have quite similar specific surface areas and micropore volumes. However, the carbon C has a very low mesopore volume, whereas carbons A and B have well developed mesoporosity, which can be clearly seen from the presence of hysteresis loops on their adsorption isotherms (Figs. 1 and 2). The α_s -plots for active carbons A (Fig. 3) and B provide an evidence of their significant external surface area, whereas the latter is very low for the carbon C. Moreover, pore size distributions for samples A (Fig. 4) and B are bimodal, whereas the PSD for the sample C exhibits only a peak arising from the presence of microporosity.

Table 1. Structural parameters for the active carbon samples.

Sample	S_{BET} (m^2/g)	V_t (cm^3/g)	V_{mi} (cm^3/g)	S_{ex} (m^2/g)
A	1260	1.05	0.47	130
B	1370	1.05	0.52	100
C	1560	0.66	0.64	15

Conclusions

Synthetic active carbons were shown to be suitable for examination of micropore analysis methods. It was also demonstrated that porous properties of active carbons can be controlled by proper choice of synthetic precursors and carbonization conditions.

Acknowledgments

Cabot Co. (Special Blacks Division, Billerica, MA) is acknowledged for providing the BP 280 carbon black.

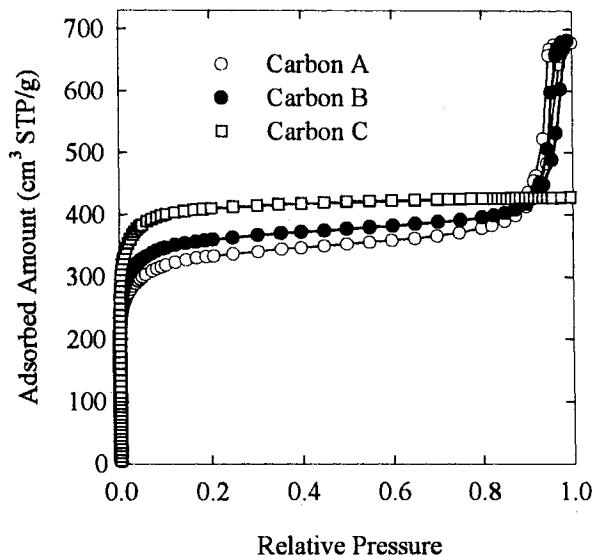


Figure 1. Adsorption isotherms for the active carbons.

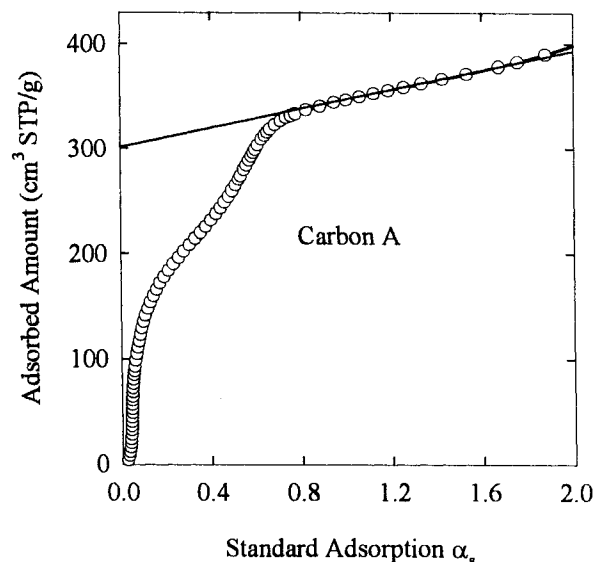


Figure 3. The α_s -plot for the active carbon A.

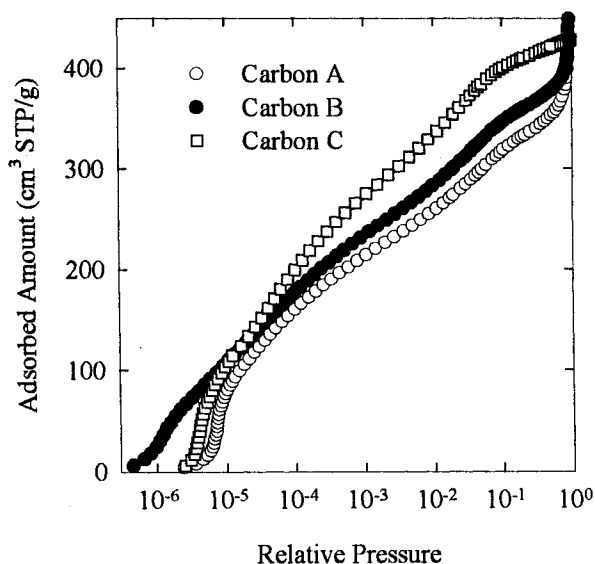


Figure 2. Adsorption isotherms shown in a logarithmic scale.

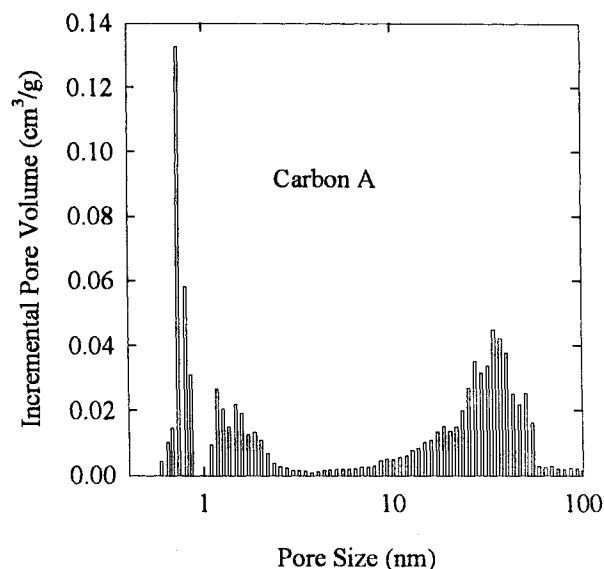


Figure 4. Incremental pore size distribution for the carbon A.

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