

EFFECTS OF SYNTHESIS TEMPERATURE OF PF RESIN AND TRIBLOCK COPOLYMERS ON ORDERED MESOPOROUS CARBONS

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Introduction

Ordered mesoporous carbon material (OMCM) can be used as separation materials, electrode materials, catalyst support and absorption materials in the field of environment protection and energy storage, so many studies have been carried out on synthesis of OMCM through organic/organic self-assemble method [1-4]. In our previous study, OMCM was prepared, and the results showed that the amount of surfactant, reaction temperature, mixing time, and carbonization temperature had direct influence of the orderliness of the mesoporous carbon's structure [5]. The aim of this paper is to investigate the effect of carbon source (PF resin) and template agent (triblock copolymers) on the structure of the resultant OMCM.

Experimental

OMCM was synthesized through evaporation induced self-assembly method using PF resin synthesized at different temperatures (75, 78, 80, 85, 88, 90, 95°C) as carbon resource and triblock copolymer F127, P123, P123/F127 as template, respectively, and the resulting materials were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM) and N₂ adsorption/desorption.

Results and Discussion

The carbon materials derived from PF resin synthesized at 75, 78, 80, 85, 88, 90, 95°C were referred to as CT75, CT78, CT80, CT85, CT88, CT90, CT95, and their XRD profiles were shown in Fig. 1. It is clear that carbon samples derived from PF resin synthesized at range of 80 to 88°C have well-organized structures, just as indicated by TEM images in Fig. 2.

It is well-known that PF resin, as the carbon source of carbon network of OMCM, should have proper molecular weight and its distribution, which can be strong enough to keep the pores after transformed to carbon, so PF resin has direct effect on the structure of OMCM.

The N₂ adsorption-desorption isotherms of the carbons CT80 and CT85 were shown in Fig. 3, and the pore structures of CT80 (A) and CT85 (B) calculated from their N₂ adsorption-desorption isotherms were listed in Table 1.

From Fig.3, we can see both CT80 and CT85 were mesoporous materials, since the isotherms are type IV with the obvious hysteresis loops. CT85 has larger mesopore surface and volume than CT80, although pore size of both samples is the same, as shown in Table 1.

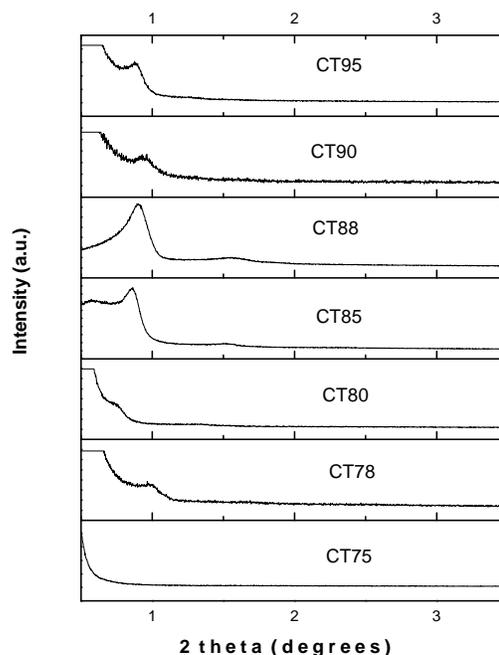


Fig. 1 XRD profiles of mesoporous carbon from PF resin polymerized at different temperatures

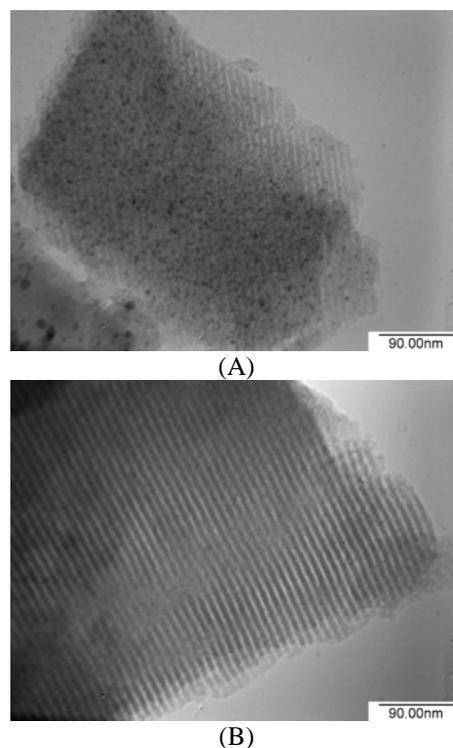


Fig. 2 TEM images of CT80 (A) and CT85 (B)

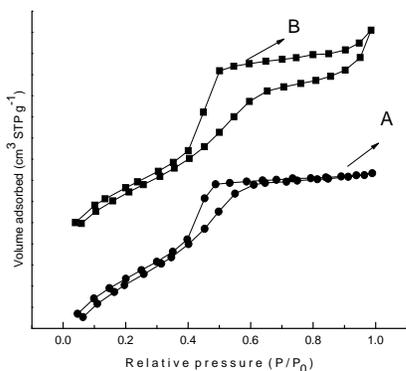


Fig.3 N₂ adsorption-desorption isotherms of CT80 (A) and CT85 (B)

Table 1. Pore parameters of CT80 (A) and CT85 (B)

	S_{BET} (m ² /g)	S_{BJH} (m ² /g)	V_{BJH} (cm ³ /g)	D_{BJH} (nm)
CT80	501	50	0.047	3.41
CT85	458	127	0.115	3.42

The TEM images of OMCN using F127 as template (a) and using F127/P123(=3/1) as template (b) were shown in Fig.4, respectively.

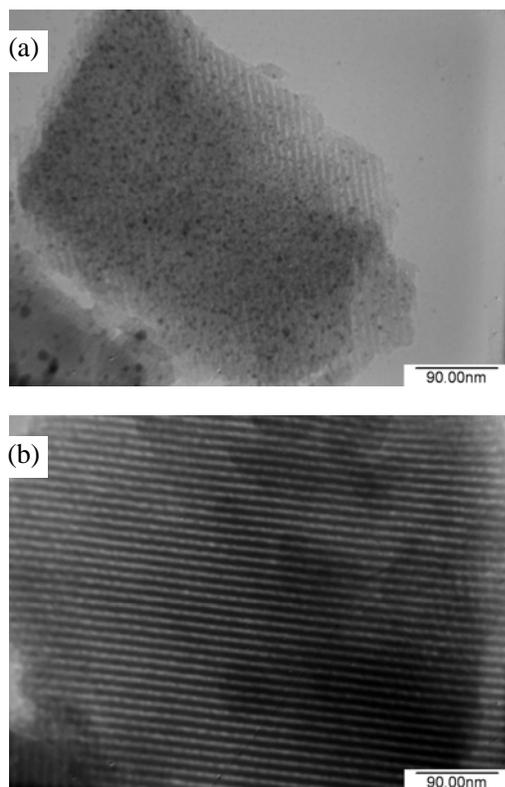


Fig. 4 TEM images of the carbons obtained using F127 as template (a) and using F127/P123(=3/1) as template (b)

The N₂ adsorption-desorption isotherms of the carbons a

and b were shown in Fig. 5, and the pore structures were listed in Table 2. It is clear that using P123/F127 is helpful to prepare carbons with well-ordered hexagonal mesostructure.

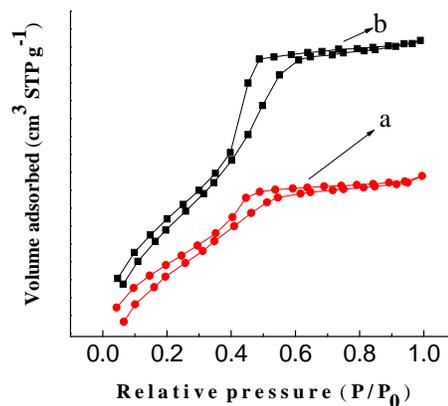


Fig.5 N₂ adsorption-desorption isotherms of sample a and b

Table 2. Pore parameters of the carbons a and b

Samples	S_{BET} (m ² /g)	S_{BJH} (m ² /g)	V_{BJH} (cm ³ /g)	D_{BJH} (nm)
a	458.0	127	0.115	3.42
b	498.5	167	0.173	3.41

Conclusions

The mesopore structure of ordered mesoporous carbon materials is related to synthesis temperature of PF resin and template. When the synthesis temperature of PF resin is 85°C, the mesoporous carbon with the BJH specific surface area of 127m²/g and average pore size of 3.41nm has a well-ordered hexagonal meso-structure, and the pore volume is enlarged to 0.115cm³/g. Hexagonal ordered structure is much easier to be formed by using P123/F127 as template than using P127. Compared with using F127 as template, using P123/F127 is helpful to prepare carbons with well-ordered hexagonal mesostructure. When the weight ratio of P123 to F127 is 1:3, OMCN is synthesized with BET specific surface area of 498.5m²/g, mesopore volume of 0.173cm³/g, mesopore surface area of 167m²/g and average pore size of 3.41 nm.

References

- [1] Viveka, A, Flodstrom, K. Influence of the block length of triblock copolymers on the formation of mesoporous silica. *Microporous and Mesoporous Materials* 2003;59:167-176.
- [2] Pius K, Andrew F, Viveka A. Triblock copolymers as templates in mesoporous silica formation: structural dependence on polymer chain length and synthesis temperature. *Langmuir* 2001;17:5398-5402.
- [3] Hu ZH, Srinivasan M, Ni YM. Preparation of mesoporous high-surface-area activated carbon. *Adv. Mater.* 2000;12:62-65.
- [4] Kruk M, Jaroniec M. Gas adsorption characterization of ordered organic-inorganic nanocomposite materials. *Chem. Mater.* 2001;13:3169-3183.
- [5] Wei GL, Zhang XJ. Influential factors of pore size and orderliness of mesoporous carbon. *The Chinese Journal of Process Engineering* 2009;9(1):181-185. (in Chinese)