ZSM-5 zeolite templated synthesis of ultra-microporous carbon using Li^+ ion effect

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Ordered porous carbons with controlled pore diameters have been of great interest in a wide range of applications, due to their pore-size effects.[1-5] Zeolite templating is one of the most effective ways to obtain ordered microporous carbons. However, the synthesis was limited to the use of large-pore zeolites with 12-membered ring, such as FAU, beta and EMT, or larger ones. Small-pore zeolites with 10-membered ring (10MR) pore apertures were considered as unsuitable templates for carbon synthesis, owing to the diffusion limitation of carbon precursors in the extremely narrow pores.

In the present work, we report an effective way to use ZSM-5 zeolite, which is one of 10MR zeolites, as a template for carbon synthesis.[6,7] ZSM-5 zeolite is an attractive template for carbon synthesis, due to its characteristic porous structure. For the synthesis of carbon, Li^+ ions were incorporated into ZSM-5 to promote acetylene carbonization selectively inside the zeolite micropores. In this work, we also tested various cations as a catalyst for the synthesis of carbon using ZSM-5 zeolite. Among the tested cations, the resultant carbon obtained from the Li^+ ion-exchanged zeolite had the similar morphology of ZSM-5 zeolite. It exhibited an ordered array of ultra-micropores of 0.5 nm in diameter, which was very close to the thickness of a pentasil layer in the ZSM-5 zeolite framework. In addition, the electrochemical performance of the resultant carbon was explored in aqueous solution.

References

[1]G. S. Chai, S. B. Yoon, J. Yu, J. Choi, Y. Sung, *J. Phys. Chem. B.* **2004**, *108*, 7074-7079.

[2]J. Yu, S. Kang, S. B. Yoon, G. Chai, *J. Am. Chem. Soc.* **2002**, *124*, 9382-9383.

[3]R. T. Mayes, C. Tsouris, J. O. Kiggans, S. M. Mahurin, D. W. DePaoli, S. Dai, *J. Mater. Chem.* **2010**, *20*, 8674-8678.

[4]C. Vix-Guterl, E. Frackowiak, K. Jurewicz, M. Friebe, J. Parmentier, F. Béguin, *Carbon* **2005**, *43*, 1293-1302.

[5]L. L. Zhang, X. S. Zhao, *Chem. Soc. Rev.* **2009**, *38*, 2520-2531

[6]K. Kim, T. Lee, Y. Kwon, Y. Seo, J. Song, J. K. Park, H. Lee, J. Y. Park, H. Ihee, S. J. Cho, and R. Ryoo, *Nature*, **2016**, *535*, 131-135.

[7]T. Lee, S. H. Ko, S. J. Cho and R. Ryoo, *Chem. Mater*. **2018**, *30*, 6513-6520.