Advanced Synthesis of Porous Carbon Spheres from Kraft Lignin with Controllable Structures through a Spray Drying Process

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Carbon spheres, an intriguing class of carbon materials, have attracted significant attention in recent years due to their remarkable physicochemical properties and great potential for diverse applications. The production of carbon-based materials from green, renewable, and cost-effective resources in accordance with sustainable development goals is a topic of high interest and encouragement. In this regard, lignin emerges as a promising sustainable source for the fabrication of advanced porous carbon materials due to its high carbon content (above 60 wt.%), low feedstock cost, abundance, and extensively crosslinked polyphenolic structure [1-3]. However, their preparation with the precise design and controllable structure using a facile and scalable strategy remains a significant challenge. The motivation for this study is to synthesize porous carbon spheres in a sustainable manner through a spray drying approach followed by a carbonization process, using Kraft lignin as the carbon source and potassium hydroxide (KOH) as the activation agent (**Figure 1**) [1,2]. Notably, our proposed method successfully controlled the structure of carbon particles from dense to hollow structure, and the surface textural properties can be easily adjusted by varying the KOH concentration. In addition, the high specific surface area (2424.8 $m^2 g^{-1}$) with a micro-mesoporous structure of hollow carbon spheres (HCSs) was obtained at a low KOH-to-lignin mass ratio (below 1.5), which was in accordance with green chemistry principles. These HCSs demonstrate potential as electrode materials in supercapacitors for energy storage devices. With the great achievements and ongoing efforts in this important field, these results suggest that our approach could pave the way for the development of advanced carbon materials and the high value-added utilization of Kraft lignin as a promising material for potential applications.

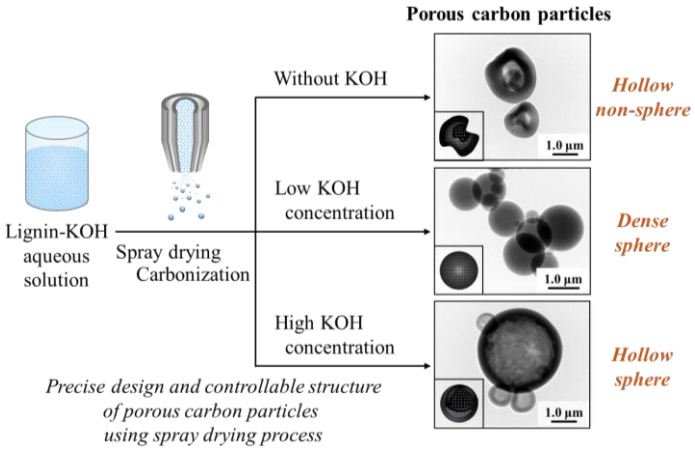

Figure 1. Schematic illustration for the preparation of porous carbon particles with controllable morphology and structure.

References

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