Title : Biomass-Devired Porous Carbon Anode Materials For Lithium-Ion Batteries

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ABSTRACT

Lithium-ion batteries (LIBs) have become the dominant energy storage technology for portable electronics, electric vehicles, and grid-scale applications due to their high energy density and long cycle life. However, the increasing demand for LIBs has raised concerns regarding the sustainability and cost-effectiveness of electrode materials, particularly conventional graphite anodes. Commercial graphite anodes are limited by their theoretical capacity of 372 mAh g^{-1}, which restricts further improvements in energy density required for next-generation applications. The development of alternative anode materials from renewable and abundant resources with enhanced electrochemical performance has therefore attracted significant research interest. Biomass-derived carbon materials have emerged as promising candidates owing to their natural abundance, low cost, environmental friendliness, and tunable physicochemical properties. Therefore, this research aims to synthesis porous carbon materials derived from various biomass wastes, including elephant ear stem, lotus leaves, lotus stems, water lettuce leaf, and water poppy stems, for application as anode materials in LIBs. The biomass precursors were converted into porous carbon through carbonization and using microwave technique with KOH activation processes. Phase characterization by X-ray diffraction (XRD) confirmed the formation of an amorphous carbon structure. Scanning electron microscopy (SEM) revealed that all samples showed the porous carbon structure of carbon materials. Electrochemical evaluation demonstrated that the lotus stem-derived porous carbon exhibited outstanding cycling stability, delivering a maximum specific capacity ~ 277 mAh g^{-1} after 140 cycles. The rate capability test further showed stable capacities across various current densities, indicating excellent rate performance and fast lithium-ion diffusion kinetics. Cyclic voltammetry (CV) curves displayed distinct redox peaks corresponding to lithium-ion intercalation and de-intercalation processes, confirming the reversible electrochemical behavior of the porous carbon materials. These results demonstrate that biomass-derived porous carbon materials offer promising potential as sustainable, cost-effective, and high-performance anode materials for lithium-ion batteries, contributing to both waste valorization and renewable energy storage applications.

Keywords : Lithium-ion battery, porous carbon, biomass waste, anode material, electrochemical performance