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Short communication

Fabrication of high voltage and energy dense supercapacitor with Manilkara zapota seeds derived porous activated carbon in acidic electrolyte

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ABSTRACT

Achieving a high working potential window beyond the water electrolysis limit (> 1.23 V) has always been a big challenge in the fabrication of aqueous supercapacitors (SCs). Since energy density has quadratic dependence on voltage, broadening of cell voltage can remarkably increase the energy density of the capacitor. Unfortunately, most of the aqueous electrochemical capacitors operated in strongly acidic or alkaline electrolytes show poor energy densities owing to their narrow operating voltage limit. To obtain a high voltage range of aqueous symmetric carbon/carbon capacitors and achieve high energy density, the chemistry of electrode materials and the electrochemical kinetics of electrolytes play a critical role. Hence, in the present work, we explore a porous activated carbon produced from the seeds of Manilkara zapota (ACMZ-700) in combination with sulfuric acid electrolyte to obtain an encouraging electrochemical stable working voltage window. Thus, the resulting symmetric SC effectively exhibited an enlarged cell voltage of 1.5 V in an acidic medium. Importantly, due to the positive role of oxygenated surface functional groups of the ACMZ-700 active material, the fabricated symmetric cell delivered an attractive specific capacitance of 334 F g^{-1} @ 1 A/g. As a result of high capacitance and broader working voltage, the symmetric device delivered an excellent energy density of 26 Wh kg^{-1} at a power density of 748 W kg^{-1} and held excellent cycling stability over 10,000 charge/discharge cycles.

1. Introduction

Heavy use of fossil fuels for energy production aroused several key issues, such as the energy shortage crisis, environmental pollution, and climate change-related problems [1]. As fossil fuel resources are draining out fast (due to their heavy consumption for energy production), there is an urge to develop advanced energy storage systems that satisfy the energy needs of the future world. In this context, electrochemical energy storage technologies have recently gathered huge attention to overcome the severe energy crisis and environmental deterioration-related issues. Until now, supercapacitors (SCs) and various rechargeable batteries are considered the most promising electrochemical energy storage systems. However, batteries have a relatively high energy density and satisfactory rate performance compared to SCs. However, the essential characteristics such as extremely long cycle life (>10^5 cycles), high-power density, and safety aspects attract the SCs over rechargeable batteries [1]. Unfortunately, due to poor energy density, the SCs are losing out on their market demand with respect to rechargeable batteries. It has been anticipated that the key to improving the energy density of the SCs to be as close to batteries as possible can be realized by carefully selecting one of its most critical components, *i.e.*, innovative electrode materials. Hence, the exploration of crucial electrode materials for SC applications is in progress to satisfy the requirement of high energy density and superior rate performance [2,3].

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