ACS Sustainable Chemistry & Engineering

Research Article

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Biowaste Sago Bark Based Catalyst Free Carbon Nanospheres: Waste to Wealth Approach

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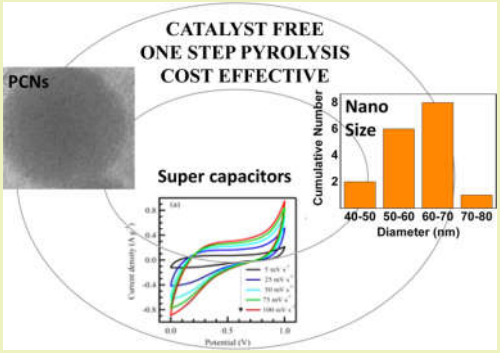
Supporting Information

ABSTRACT: Catalyst-free carbon nanospheres were synthesized using simple one-step pyrolysis techniques where biowaste sago bark is used as a carbon precursor. Obtained carbon nanospheres showed a porous nature and revealed that more than 95% carbon is present in the synthesized carbon nanospheres with particle size ranging from 40 to 70 nm. An electrochemical study showed a specific capacitance value of 180 F g^{-1} at 2 mV s^{-1} and the cycling stability up to 1700 cycles. Obtained carbon nanospheres are useful in supercapacitor applications. The presented study revealed a waste to wealth approach thereby reducing waste in the environment.



KEYWORDS: *Sago bark, Nanoporous carbon, Pyrolysis, Supercapacitors, Waste to wealth*

INTRODUCTION

Carbon-based nanomaterials have promising applications in nanoelectronics,[1] microelectrical devices,[2] electrochemistry,[3,4] sensors,[5] catalysis,[6] and ultracapacitors.[7−9] Among different forms of carbon nanomaterials,[10−13] carbon nanospheres are gaining interest because, in its spherical arrangement, they are normally unclosed shells with rather waving flakes that follow the curvature of the sphere. This forms many open edges at the surface creating reactive "dangling bonds," which provides the spheres with high chemical activity, establishing them as good candidates for their use in various applications.[11]

Various methods have been reported for the synthesis of carbon nanosphere transition and/or rare earth metal oxides as catalysts[14] and carbon nanospheres from the carbonization of polyethylene−poly(vinyl chloride) in a sealed gold tube under a pressure of 30 MPa,[15] in carbon vapor from the decomposition of β-SiC powder,[16] etc. Carbon nanospheres of 20−500 μm are found as a side product in the synthesis of fullerene by the deposition of gaseous carbon.[17] Arc discharge and laser ablation methods have also been used for the synthesis of structured carbon.[18,19] Although the catalytically assisted chemical vapor deposition method has emerged as a promising technique,[20] an economically viable method for the preparation of a bulk quantity of carbon nanospheres under reasonable experimental conditions is still lacking to date. Many methods use petroleum products as a source for carbon material preparation, which has a negative environmental impact, and also these methods suffer from many problems such as the production of a significant quantity of undesired byproducts, additional purification steps, low yields and high energy requirements, high cost production, etc. Thus, the need for alternate carbon sources for the synthesis of environmentally friendly, cost-effective carbonaceous materials is the present day's requirement.

On the other hand, carbon materials with a high degree of porosity and high specific surface area are employed in the development of advanced energy storage systems such as electrochemical capacitors.[21−25] An electrical/electrochemical double layer capacitor (EDLC), also known as a "supercapacitor" or "ultracapacitor," is a promising one, which is characterized by energy density in the range of 1−10 W h kg and a power density of 1−10 kW kg. These high parameters influence the replacement of the batteries as storage media by EDLC in many systems where traditional batteries are used (e.g., hybrid electric vehicles, power back-up systems, UPS,

Received: June 10, 2015
Revised: July 27, 2015
Published: July 28, 2015

DOI: 10.1021/acssuschemeng.5b00517
ACS Sustainable Chem. Eng. 2015, 3, 2247−2253