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Yan Zhong, Tielin Shi, Yuanyuan Huang, Siyi Cheng, Guanglan Liao, Zirong Tang

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One-step Synthesis of Porous Carbon derived from Starch for All-Carbon Binder-Free High-Rate Supercapacitor

Yan Zhong[1], Tielin Shi[1,] Yuanyuan Huang[1], Siyi Cheng[1], Guanglan Liao[1,] and Zirong Tang[1]*

1 State Key Laboratory of Digital Manufacturing Equipment and Technology, Huazhong University of Science and Technology, Wuhan 430074, People's Republic of China

Corresponding author:E-mail: zirong@hust.edu.cn

Abstract

Fast charge–discharge capability even at high current densities is desired for supercapacitor. One-step simple synthesis using sol-gel method is used to fabricate binder-free activated carbon electrode, where KOH was used to tune the porosity of electrode. The gravimetric capacitance of the optimized electrode is up to 272 F g^{-1} at a current density of 1 A g^{-1}. More importantly, 75.9 % gravimetric capacitance retention is kept at an ultrahigh current density of 50 A g^{-1}. Furthermore, a symmetrical supercapacitor device is assembled in 1 M Et_4NBF_4 in acetonitrile, which delivers an energy density of 18-25 W h kg^{-1}. Apparently, the carbon material with open rich pores provides short ion diffusion pathways for energy storage and the binder-free method guarantees high conductivity of the whole system, leading to high-rate performance. The porous carbon structure as well as the low-cost and simple design paves the way for fabricating supercapacitors with enhanced rate capability.

1. Introduction

Supercapacitors (SCs) are making their way into various electronics markets due to their fast charging/discharging capability and stable life cycling [1-4]. Compared with the pseudo-capacitive material, carbon-based material wins in its good conductivity and fast charge–discharge capability from the electrical double layer.

Recently, different types of carbon materials are fabricated and used as supercapacitor material, such as graphene[5-7], CNTs[8, 9], activated carbon[10-12] derived from organic matter and biomass. Although high capacitance is usually achieved at a low current density, a big loss in capacitance is obtained at high current density, leading to a poor rate performance. For example, the capacitance of activated porous