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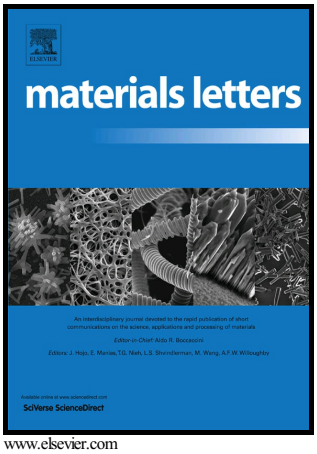

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Phosphorus-doped pitch-derived soft carbon as an anode material for sodium ion batteries

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Abstract

A pitch-derived soft carbon is successfully prepared by easy-accessible pyrolysis process in this work. The electrochemical performance of the acquired soft carbon can be improved via doping phosphorus. We found that the phosphorus doping can increase layer spacing and defects of soft carbon, which improved the capacity of soft carbon significantly. The cell's initial reversible capacity of the phosphorus-doped pitch-derived soft carbon is as high as 251 mAh g^{-1}, the capacity retention has been kept at 80.1% after 200 cycles. Herein, phosphorus doping is an effective way to improve the electrochemical performance of the pitch-derived soft carbon while phosphorus doped soft carbon is a promising candidate as an anode material for sodium ion batteries.

Keywords

Carbon materials; Phosphorus-doping; Anode material; Sodium ion battery; Raman; XPS

1. Introduction

Sodium ion batteries (SIBs) were originally researched in 1980's [1, 2]. Due to sodium's advantages such as high abundance, low cost and suitable redox potential, many researchers consider SIBs as a promising candidate for large-scale energy storage and automotive applications [3, 4]. Since Na ion's radius is about 40% larger than that of Li ion, it is difficult to insert into the intercalation hosts. Thereby the intercalation hosts must have larger channels or interstitial sites to accept Na ion. The development of the anode material for SIBs is slow, because graphite, which is widely used as the lithium ion batteries anode material, cannot be used as the intercalation material for SIBs [5, 6]. Considering the superior performance as well as the low cost, other carbon-based materials still hold promise. Extensive work has been done on the mechanisms and the applications of hard carbon and soft carbon. Nevertheless, the hard carbon with high capacity is still expensive for commercialization and the soft carbon with much lower cost delivers a lower capacity of about 100 mAh g^{-1} [7]. An effective strategy to increase the capacity of