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Short communication

Simple and fast synthesis of polyaniline nanofibers/carbon paper composites as supercapacitor electrodes

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ABSTRACT

A simple and fast electrochemical polymerization method is used to prepare polyaniline nanofibers supported on carbon paper. The composition and morphology of the obtained composites are characterized by infrared spectroscopy, X-ray diffraction and scanning electron microscopy. It is found that an aligned polyaniline nanofiber array is uniformly supported on carbon paper substrate. This unique array architecture provides good electrochemical supercapacitor performances for the obtained composites. A specific capacitance as high as of 531 F g^{-1} at a current density of 3 mA cm^{-2} is achieved. The research data show that acceptable electrochemical properties can be attained by controlling the structure of supercapacitor electrode.

1. Introduction

Due to their high theoretical specific capacitance, polyaniline (PANI) composites are regarded as one of the most promising electrode materials for supercapacitors [1]. For obtaining high performance PANI electrodes, various chemical preparation methods have been developed such as chemical oxidative polymerization [2], templates or surfactants synthesis [3–5], seeding synthesis [6], interfacial polymerization [7,8], dilute polymerization [9] and oligomer assisted polymerization [10] *etc.* Although the above-mentioned chemical preparation methods have many advantages, the residual additives such as templates, oxidants and surfactants and so on gravely influence the electrochemical properties of the resulting PANI electrodes. As a consequence, many efforts are devoted to developing novel and controllable synthetic methods for preparing high-pure PANI, especially electrochemical method [11]. For instance, Wang et al. [12] have prepared PANI nanofibers by an electrochemical oxidation method at a constant current of 0.01 mA cm^{-2} for 1 h. Liang et al. [13] have deposited PANI nanowires supported on different substrates at a galvanostatic current density of 0.08 mA cm^{-2} for 0.5 h, followed by 0.04 mA cm^{-2} for 3 h, which was then followed by another 3 h at 0.02 mA cm^{-2}. Horng et al. [14] have synthesized carbon cloth supported PANI nanowires by a two-step electrochemical method, *i.e.* linear potential sweep voltammetry in combination with galvanostatic method. The aforementioned electrochemical methods are either relatively complicated or time-consuming. Therefore, it is significant for developing a simple and fast electrochemical polymerization method for preparing high-pure PANI.

Herein, a simple and fast electrochemical polymerization method is proposed to fabricate PANI nanofibers supported on carbon paper (denote as PANINF/CP) composites without polymer binders and conducting additives. All the electrochemical polymerization processes are completed within 3 min at a constant current density of 60 mA cm^{-2}. It is observed that aligned array PANI nanofibers are uniformly deposited on the surface of carbon paper and the obtained PANINF/CP composites display high specific capacitance when used as supercapacitor electrode.

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2. Experimental

2.1. PANINF/CP composites synthesis

All the chemicals purchased from Sinopharm Chemical Reagent Co. were of analytical grade and used as received without further purifications. Hydrophilic carbon paper substrate (TGP-H-60, 78% porosity) with a thickness of 190 μm was provided by Toray.

The PANINF/CP composites are prepared by an electrochemical polymerization method using a conventional three-electrode system. A piece of carbon paper, platinum sheet and saturated calomel electrode are used as the working electrode, counter and reference electrode, respectively. Electrolyte solution is a mixture of 0.2 M aniline and 0.6 M $HClO_4$. All the electrochemical polymerization processes are completed within 3 min at a constant current density of 60 mA cm^{-2} and carried out at room

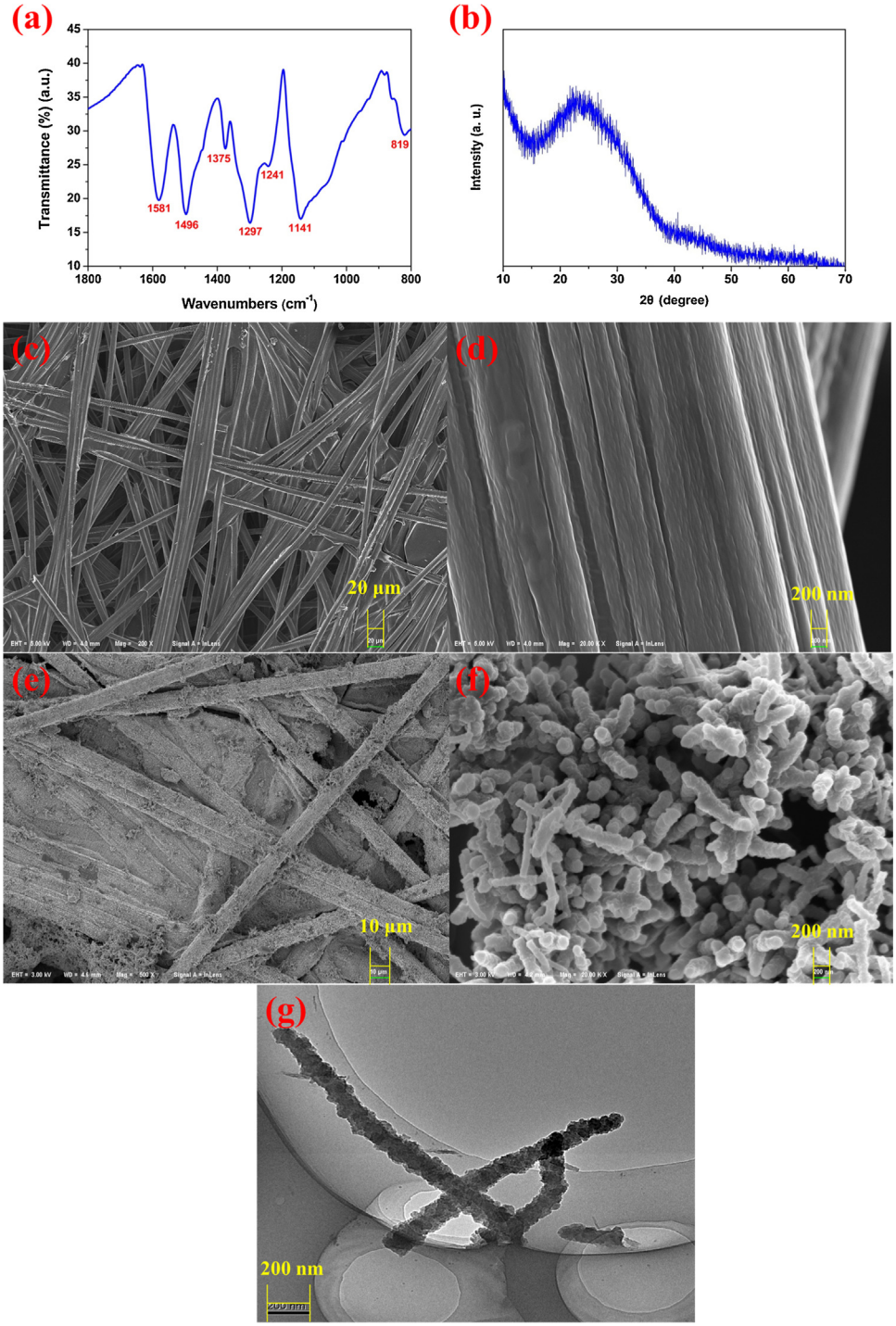

Fig. 1. The infrared spectrum (a) and X-ray diffraction patterns (b) of products; the SEM images of carbon paper before (c, d) and after (e, f) the PANI composites deposition; the TEM images of PANI nanofiber (g).