전기방사를 이용한 PEDOT 부직포의 전기화학적 특성

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Fabrication and Properties of PEDOT Fiber Non-woven Web Prepared by Electrospinning

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1. Introduction

Electrospinning is an efficient technique to produce polymer non-woven web with diameters of polymer filament fibers ranging from 5 to 500 nm[1-3]. The instrumentation consists of nozzle of capillary dimensions, a collecting mandrel and high voltage source. The electric field created between the capillary and the collector pulls the polymer solution from the nozzle. The main application of the technique itself and of electrospun fibers are in the fields of biomedicine (especially tissue engineering), filtration media (e.g protective clothing), and nano-electronics (e.g conductive polymer for sensors and capacitors)[4]. In this study, we fabricated electrically conducting nano (micro) poly(3,4-ethylenedioxythiophene) (PEDOT) fiber non-woven web using a novel electrospinning technique and investigated various properties of the web. We measured the electrical conductivity and observed surface morphologies of the electrically conducting PEDOT fiber non-woven web. We also measured specific discharge capacitance of electrochemical capacitor.

2. Experiment

2.1. Electrospinning

Electrospinning solution was prepared by mixing the monomer (3,4-ethylenedioxythiophene) (EDOT) and oxidant (ferric p-toluene sulfonate) (FTS). The monomer solution was formed by dissolving various amounts of poly(vinyl pyrrolidone) (PVP, avg. mol. wt. 360,000 g/mol) , EDOT and 1-methyl-2-pyrrolidone (NMP). The oxidant solution was prepared by dissolving FTS in 1-propanol or 1-butanol. The electric voltage ranging 10 - 30 kV was applied by the high voltage power supply. The electrospinning solution was extruded at the rate of 1 ~ 10 ml/hr by the syringe pump, and the tip-to-collector distance (TCD) was in the range of 130 - 180 mm. The electrospun nano (micro) fiber non-woven web collected on the metal collector was heated at 100℃ to polymerize EDOT in the spun fiber. Finally we washed the spun fiber with methanol to remove residual materials and dried in the oven for 1 hr.

The surface morphology of electrically conducting PEDOT nano (micro) fiber non-woven web was observed by optical microscope and scanning electron microscopy (SEM).

2.2. Measurements of electrical conductivity and electrochemical capacitance

The electrical conductivity of PEDOT non-woven web was measured by using Van der Pauw's four-probe method, where the sample was prepared by compressing the web to a pellet. A symmetrical electrochemical capacitor was assembled using one pair of PEDOT non-woven web with the area of 1 x 1 cm^2 as the electrode by simple stack method. Applying a cyclic galvanostatical charge/ discharge current, the discharge capacitance was calculated by multiplying the applied current by the discharge time of the electrochemical capacitor, where 0.1 M Et_4NBF_4/propylene carbonate solution was used as the electrolyte solution.

3. Results and discussion

Electrical conductivity of the compressed PEDOT web spun from the EDOT solution (EDOT : PVP = 10 : 7) in 1-propanol was as high as 7.5 S/cm. Figure 1 shows the charge and discharge characteristics of the electrochemical capacitor using PEDOT non-woven web as electrode, indicating that PEDOT fiber non-woven web possessed electrochemical activity. The specific discharge capacitance of the capacitor was about 16.5 F/g and showed little decrease after 50 cycles as shown in Fig. 2.

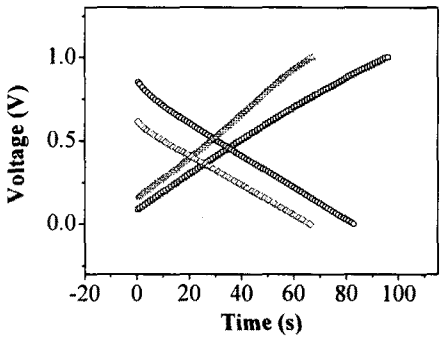

Fig. 1. Charge and discharge curves (0 - 1 V) of the 1st and 50th cycle of the electrochemical capacitor assembled using one pair of PEDOT non-woven webs as the electrode in 0.1 M Et_4NBF_4/propylene carbonate electrolyte solution

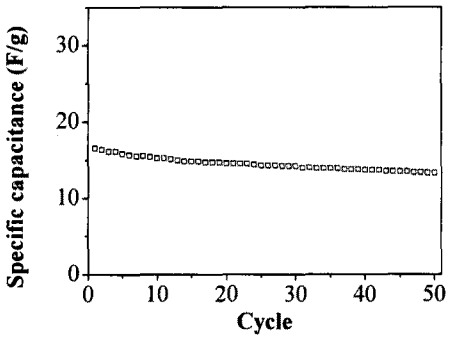

Fig. 2. Specific discharge capacitance of the electrochemical capacitor assembled using one pair of PEDOT non-woven webs as the electrode in 0.1 M Et_4NBF_4/propylene carbonate electrolyte solution.

4. Conclusions

In this study, we successfully fabricated electrically conducting nano (micro) PEDOT fiber non-woven web with large specific surface area using the simple electrospinning technique. When 1-propanol was used as the solvent, spinnability and the conductivity of PEDOT fiber non-woven web was better than when 1-butanol was used as the solvent. The PEDOT non-woven web possessed both quite high electrical conductivity of 7.5 S/cm and electrochemical activity. The specific discharge capacitance of the symmetric electrochemical capacitor assembled using PEDOT non-woven web as the electrode was 16.5 F/g.

Reference

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