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PREPARATION OF PVA-BASED CARBON NANO-FIBERS AND THEIR ELECTRO-CHEMICAL PROPERTIES

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Introduction

Poly vinyl alcohol (PVA) is a material generally used in glue. To use thermoplastic resin for a carbon material has not been focused due to its low carbonization yield. However, it has been reported that the carbonization yield is improved up to about 30% by pretreatment with iodine vapor[1]. Since PVA is a water-soluble polymer and easily forms a mixture with other water-soluble substances, it is likely to provide environmental friendly CNF preparation method. In this study, PVA nanofibers were prepared by electrospinning from PVA aqueous solution containing potassium iodine (KI), and carbon nanofibers (CNFs) were prepared without iodine vapor pretreatment[2]. Electrochemical characteristics of CNF were evaluated for an electric double-layer capacitor (EDLC). This study gives ecofriendly CNF preparation method.

Materials and Methods

The aqueous solution of PVA (9.0 wt.%), KI (0.45 wt.%), and polyethylene glycol (PEG, Mw=2000) (1.0 wt.%) was used for an electrospinning. PEG was used to adjust the viscosity of the solution. The electrospinning setup is shown in **Figure 1**. The setup includes a high voltage power source, a syringe pump, and a drum collector. Electrospinning was performed by applying voltage of 19 kV between the syringe needle and the collector (200 mm), a solution feed rate of 0.65 mL/h, and a rotation speed of the drum collector of 40 rpm. The PVA nanofibers were treated and stabilized at 195 °C for 6 h in air. The stabilized nanofibers were carbonized at 800 °C (heating rate: 2.0 °C/min) under a N_2 gas atmosphere. The CNF was washed with pure water to remove K^+ from CNF. The characteristics of CNF were evaluated by Scanning electron microscope (SEM) (SU3500, Hitachi High-Technology) and energy dispersive X-ray spectroscopy (EDX), cyclic voltammetry (CV) using potentio-galvanostat (SP150, Bio-Logic) measurement. For the EDLC evaluation, a 2-pole cell (HS-cell, HOSEN), 1M-tetraethylammonium tetrafluoroborate (Et_4NBF_4)/ propylene carbonate (PC) was used as the electrolyte.

Results and Discussion

Figure 2 shows (a) PVA nanofibers and (b) carbonized nanofibers. The PVA nanofiber was not melted and its shape was maintained after carbonization. The average diameter of CNF was about 200 to 300 nm. The EDX analysis was performed for unwashed and washed CNF. **Table 1** shows that K^+ was effectively removed by washing with water. Although the unwashed CNF contained the component of K, the component of K was not seen after water washing, and it is thought that K was eluted in water. **Figure 3** shows that CV measurement (-2.5 ~ +2.5V, 20 mV/s). The capacitance was calculated from the current value at 0 V in the CV curve. **Table 2**

shows the capacitance of each sample. The capacitance of CNF increased to 1.22 F/g after washing, whereas 0.66 F/g before washing.

References

1. M. Sashio, M. Tanaka. (1985). Thermal reaction of poly(vinyl alcohol) - iodine complex membranes. *J. Polym. Sci. Polym. Chem. Ed.*, 23 (3), 905-909
2. K. Oshida, et al. (2016). DEVELOPMENT OF HIGH PERFORMANCE NANO CARBON COMPOSITES BY USING AGRICULTURAL PRODUCTS. *Carbon* 2016.

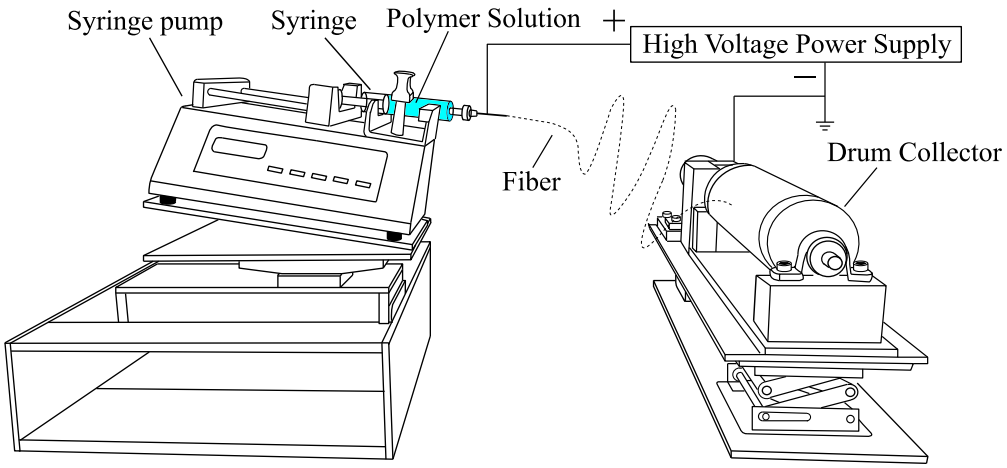

Figure 1. The electrospinning setup

Table 1. Atomic compositions of unwashed and washed CNF analysed by EDX.

Sample	C	O	K
Unwashed CNF	95.43	4.32	0.24
Washed CNF	94.97	5.03	0

Table 2. The result of cyclic voltammetry.

Sample	Capacity [F/g]
Unwashed CNF	0.66
Washed CNF	1.22

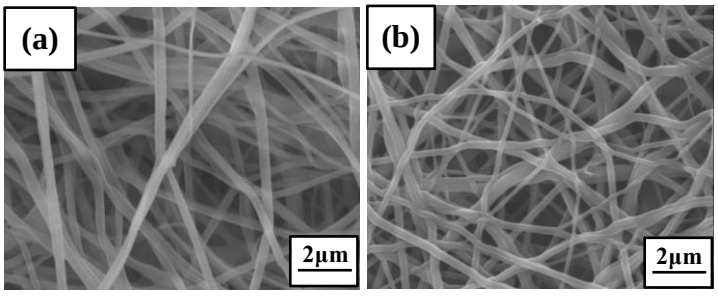

Figure 2. The SEM images of PVA nanofibers and carbon nanofibers. (a) PVA nanofibers, (b) carbon nanofibers

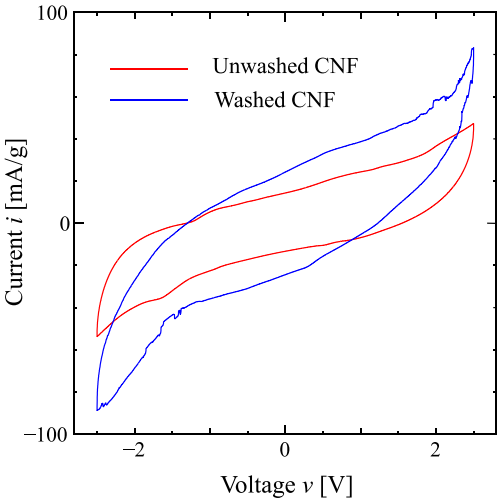

Figure 3. Cyclic voltammograms.