전기방사 시스템을 통한 나노파이버로 구성된 다공성 기질의 제조와 특성분석

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Characterization and Fabrication of Porous Substrates Consisted with Nano-Fibers via Electro-Spinning Deposition (ESD) System

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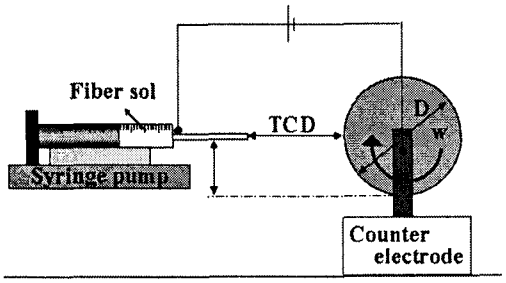
1. Introduction

The electro-spinning process is driven by the electrical forces on free charges on the surface or inside a polymeric liquid and it provides a straightforward way to produce long polymer fibers with diameters in the range of 40 - 2000 nm [1]. Electro-spinning of polymer solutions can produce thin fibers and it has been shown great applicable potentials due to its outstanding advantages for the field in which high surface area is required. Recently several researchers reported the great potential of electro-spun fibers as a porous fiber mat or a media as an ion exchanger in secondary battery [2] and a previous study showed an improved performance in ionic conductivity of polymer electrolyte in aqueous state by substituting a conventional membrane with a corresponding nano-scaled fibrous mats produced using the electro-spinning process [3]. The morphology of electro-spun fibers depends on various parameters such as viscosity, conductivity, surface tension of solutions, applied voltage, injection rate, tip-to-collector distance (TCD), temperature and humidity as well. In this study, a polymer nanofibers were electro-spun and deposited fiber mat was prepared as porous substrates. Also the applicable potential was discussed.

2. Experimental

BPPO (brominated poly(2,6-dimethyl-1,4-phenylene oxide)) was used and it was purified based on the solubility in NMP (N-methyl-2-pyrrolidone) (Junsei) via centrifuging (13000 rpm., 15℃ for 30 min.) and phase inversion processes. BPPO was considered as a good material due to its good leaving group (-Br) for further applications and its characteristics such as good mechanical and thermal properties [4].



[Fig. 1 Schematic of electro-spinning deposition (ESD) system]

BPPO was well dissolved in NMP and homogeneous solutions was obtained. BPPO solutions in NMP (BNMPs) was electro-spun at ambient conditions; temperature and humidity were around 20 ℃and 30 % respectively. As shown in Fig. 1, several parameters including applied voltage (kV), tip-to-collector distance (TCD, cm) and injection rate (mL/hr) were investigated to observe morphological appearances of electro-spun nanofibers. The shape and size of electro-spun BPPO nanofibers were characterized by meaning of scanning electron microscopic appearances.

3. Result and Discussion

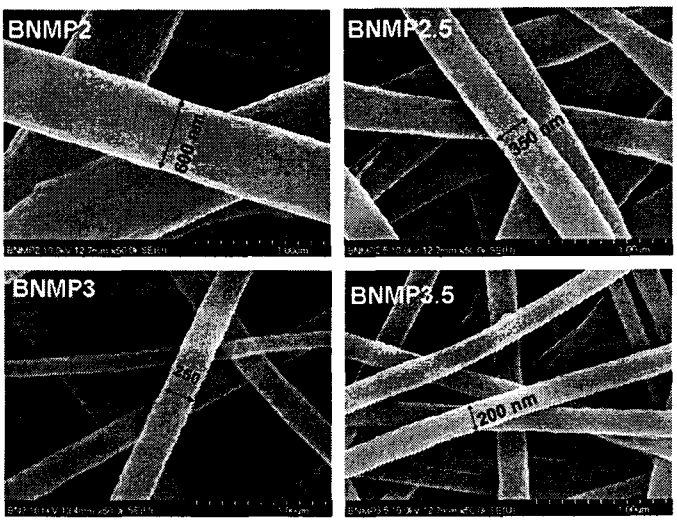
Electro-spinning of BNMPs was available under various concentrations as shown in Table 1 and NMP showed excellent electro-spinnability under ambient environment. Injection rate was fixed at 0.30 mL/hr, tip-to-collector distance (TCD) was 10 cm and 1g of BPPO was electro-spun at 16 kV.

[Table 1 Electro-spinning conditions for BNMP nanofibers]

Sample	Conc. (g : mL)	ESD conditions			Fiber Diameter (nm)
		Appled voltage (kV)	TCD (cm)	Injection rate (mL/hr)	
BNMP2	1 : 2.0	16	10	0.30	600
BNMP2.5	1 : 2.5	16	10	0.30	350
BNMP3	1 : 3.0	16	10	0.30	250
BNMP3.5	1 : 3.5	16	10	0.30	200
BNMP4	1 : 4.0	16	10	0.30	NF*
BNMP5	1 : 5.0	16	10	0.30	NF*

*NF (no fiber) : fiber was not electro-spun

Eventually the concentration effect of BPPO solutions in NMP on the resulting fibers was observed by meaning of scanning electron microscopic appearances as shown in Fig. 2.



[Fig. 2 SEM images of the electro-spun BNMPs illustrating the effect of polymer concentrations on the fiber diameter]

Fiber diameter was decreased with the decrease of BPPO concentration and the threshold concentration was between BNMP3.5 and BNMP4. Electro-spun BPPO nanofibers were homogeneously deposited on the aluminum foil which was wrapped up the counter electrode and the resulting mat could be prepared as a porous substrate

via pressing process. This novel porous substrate can be used for filtration or membrane for fuel cells and secondary battery system as a supporter or ion exchanger after introducing ion exchangeable capacity as well. Our further work includes these application challenges.

4. Concluding Remarks

In this study the effect of polymer concentrations on the electro-spun BPPO nanofiber diameter was illustrated by meaning of scanning electron microscopic appearances. It was confirmed that the electro-spun BPPO nanofiber diameter could be controlled from 600 at BNMP2 to 200 nm at BNMP3.5. The threshold concentration for fiber spinning was observed at BNMP4. Therefore, the BPPO nanofiber diameter could be controlled by electro-spinning diluted polymer solution ahead of threshold concentration.

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