FABRICATION OF PU–PVDF CORE-SHEATH NANOFIBERS BY COAXIAL ELECTROSPINNING

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INTRODUCTION

Electrospinning is a process for fabricating continuous nanoscale fibers with diameters in the sub-micrometer to nanometer range using a high-voltage power supply [1]. Electrospun (e-spun) fibers and nonwoven webs that are manufactured from these e-spun fibers have attracted considerable attention because of their outstanding characteristics, such as high porosity, small diameter, excellent pore interconnectivity, and high surface-to-volume ratio [2]. However, some problems have been encountered in the electrospinning of blends of two chemically different polymers, in which the polymer blend solutions are not homogenous owing to different solvent systems [3]. One way to overcome these complicated issues is to electrospin two polymer solutions simultaneously in a coaxial electrospinning technique [4–7].

Experimental

Coaxial electrospinning process

The coaxial electrospinning process consists of a high-voltage power supply, a collector, and twin spinnerets (Nano NC, Korea), as shown in Figure 2. mm) in which volume feed rates of each spinneret can be controlled separately. Coaxial electrospinning was carried out with a distance of 10 cm between a needle tip to the collector and the high-voltage power supply was 15 kV

Characterization

The samples observed by using an FE-SEM (JSM-T300; JEOL, Japan). The wettability of the e-spun nonwoven web was investigated using contact angle analysis (SFA-410ED; Samsung, Korea). A drop of purified water was deposited onto the nonwoven web surface using a microsyringe attached to a goniometer.

RESULTS AND DISCUSSION

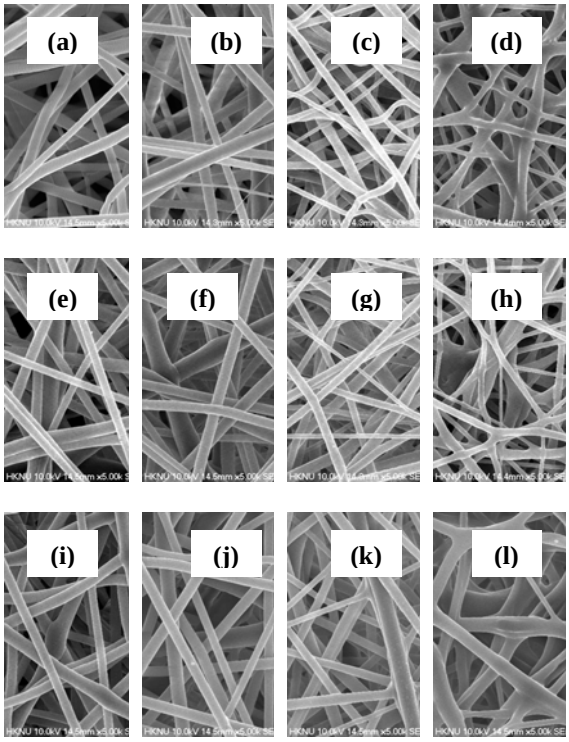

Figure 1. Morphology of PVDF–PU nonwoven webs with 10 %wt concentration of the core solution at a volume feed rate of (a) 0.06, (b) 0.1, (c) 0.5, and (d) 1.0 ml/h; with 15 %wt concentration of the core solution at a volume feed rate of (e) 0.06, (f) 0.1, (g) 0.5, and (h) 1.0 ml/h; and with 20 %wt concentration of the core solution at a volume feed rate of (i) 0.06, (j) 0.1, (k) 0.5, and (l) 1.0 ml/h.

Figure 1 shows FE-SEM pictures of the morphology of the PVDF–PU nonwoven webs. Core volume feed rates of 0.06 and 0.1 ml/h resulted in uniform e-spun fibers, but core volume feed rates of 0.5 and 1.0 ml/h resulted in fused e-spun fibers. With an increase in the core solution concentration, uniform e-spun fibers were observed with core volume feed rates of 0.06, 0.1, and 0.5 ml/h, as shown in Figure 3(a–g, i, and j).

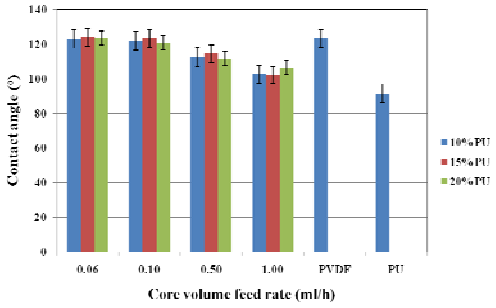

Figure 2. Water contact angle of the nonwoven webs of polyurethane (PU) (core) with different concentrations (10, 15, and 20 wt%) and polyvinylidene fluoride (PVDF) (sheath) with a fixed concentration of 20 wt%.

PVDF–PU nonwoven webs fabricated at volume feed rates of the core solution of 0.06 and 0.1 ml/h showed similar contact angle values as PVDF nonwoven webs. This finding indicated that the sheath of e-spun fibers of the nonwoven webs is PVDF.

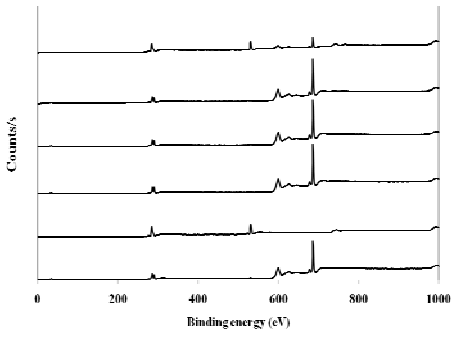

Figure 3. XPS spectra of nonwoven webs (a) PVDF and (b) PU, and ATR FT-IR spectra of PVDF–PU nonwoven webs fabricated with core volume feed rates of (c) 0.06, (d) 0.1, (e) 0.5, and (f) 1.0 ml/h.

The structure of the core–sheath e-spun fibers can be verified by examining the chemical composition on the surface of the e-spun fibers using XPS, as shown in Figure 3. PVDF is composed of only carbon (C1s) and fluorine (F1s) and is found in the XPS spectrum of PVDF (Figure 6 (a)), while PU is composed of C1s and oxygen (O1s) (Figure 3 (b)).

Conclusion

The core–sheath of PU–PVDF nanofibers was successfully fabricated from PU (core) and PVDF (sheath) using the coaxial electrospinning technique. The core–sheath structure of a PU–PVDF e-spun fibers, was obtained by using a core solution feed rate of less than 1.0 ml/h, was confirmed by XPS analysis and by water contact angle measurement.

References

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