전기방사된 PVDF 섬유웹의 전기적 특성에 있어 입자의 영향

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Influence of Particles on the Electrical Properties of Electrospun PVDF Fiberwebs

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1. Introduction

Electrospinning is a novel process for forming fibers with submicron scale diameters through the action of electrical force. In the previous study, we performed study on the ultrafine PVDF nanofiber production in the stable spinning condition. Recently it would be great interest to fabricate IP(inorganic particle) assemblies in nanofiber since such IP/nanofiber hybrid materials might be used in a nonwoven form as nanowires, medical gauges for burns healing and cell growing, sensors, chemical and gas filteration. Each of IP and nanofibers could be designed to have desired functionality. Furthermore degradation rate of nanofibers is 100 folds faster than that of conventional polymer fiber, which is significance in environmental protection or design of biodegradable scaffolds. Thus we are interested in the effect of IP such as CB(carbon black), ZrO_2, TiO_2 and Al_2O_3 in the PVDF nanofibers. In this study, we studied variation of the spinning behavior with different content of IP at the constant electrical force. And we observed differences of the electrical conductivity and spinning behavior with the samples produced according to different content of IP.

2. Experimental

PVDF chip was purchased from the Solvay company. Its weight average molecular weight is 100,000g/mol. The used solvent was N,N-dimethylacetamide(DMAc). And the used IP was CB, ZrO_2, TiO_2 and Al_2O_3 purchased from the Aldrich company. 20g PVDF was dissolved in 80g DMAc under magnetic stirring during 24 hours at 60℃. And then we stirred mixture solution added inorganic particles into the PVDF solution during 5 hours at 10℃. The mixture solution was electrospun by changing with the different electrical force(kV/cm). The electrical conductivity of IP/PVDF solution was measured by conductivity meter(Istek Co.). On the other hand, the surface electrical conductivity(CMT-SR 1000, Changmin Co.) of the IP/PVDF nanofibers was measured by a four probe technique.

3. Results and discussion

Figure 1 shows the variation of the solution electrical conductivity with IP content from 0 to 2.0wt.%. That is increased with increasing the IP content. When CB is added to 2.0wt.%, that is the highest 7.5μs/cm because the dielectric constant of CB is the highest. Figure 2 shows the difference of spinning behavior by electrospinning at the electrical force of 0.40kV/cm with each of solutions mixtured 2.0wt.%. The solutions added TiO_2 and Al_2O_3 droped because the electrical density in the fluid generated at 0.40kV/cm is smaller than the surface tention of solution. But the

solutions added CB and ZrO_2 formed jet at the same electrical force and spray IP/PVDF nanofibers and then sometimes dropped. The solution electrical conductivity is due to have an effect on the spinning behavior. Figure 3 shows the necessary electrical force to appear the conventional four mode at the constant solution conductivity of 4.5μS/cm with different four solutions. The spinning behavior is simillar in the same solution electrical conductivity. Figure 4 shows the surface electrical conductivity of electrospun IP/PVDF nanowebs. Electrical conductivity of IP/PVDF is varied by species of IP and increase with IP content. That of CB/PVDF blended fibers is the highest 5.7×10^{-8}S/cm.

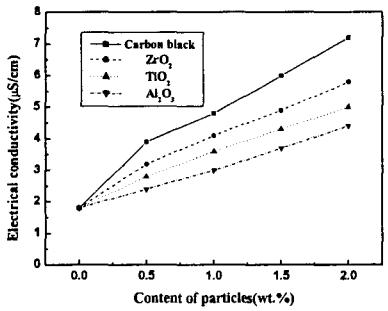

Figure 1. Electrical conductivity of the solution produced with different content of IP.

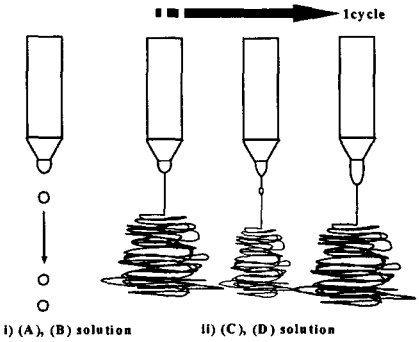

Figure 2. Variation of spinning behavior with solution conductivity at the electrical force of 0.40kV/cm.
(A: TiO_2, B: Al_2O_3, C: ZrO_2, D: carbon black)

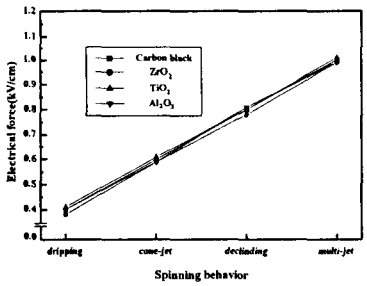

Figure 3. Spinning behavior with different electrical force

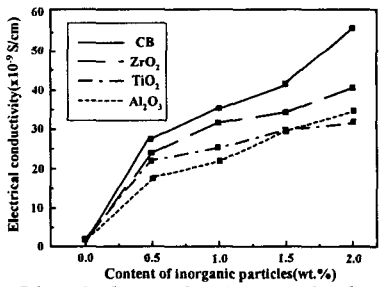

Figure 4. Electrical conductivity of electrospun composite nanowebs produced with different content of inorganic particles.

4. Conclusion

Electrical conductivity of IP/PVDF is varied by species of IP and increase with IP content. The changed solution electrical conductivity have an effect on the spinning behavior. And the higher solution electrical conductivity has, the higher surface electrical conductivity of the electrospun IP/PVDF composite nanowebs has.

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5. References

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