용매의 특성이 전기 방사한 폴리비닐아세테이트 나노섬유의 직경에 미치는 영향

고정안, 김관우, 강효경*, 길명섭*, 김학용*
전북대학교 바이오나노시스템공학과, *전북대학교 섬유소재시스템공학과

The Effect of Solvent Properties on the Diameter of Electrospun Poly(vinyl acetate)(PVAc) Nanofibers

Jung-An Ko, Kwan-Woo Kim, Hyo-Kyoung Kang*, Myung-Seob Khil*, Hak-Yong Kim*
Department of Bionanosystem Engineering, Chonbuk National University, Jeonju, Korea
**Department of Textile Engineering, Chonbuk National University, Jeonju, Korea*

1. Introduction

Electrospinning is an interesting process for producing fibers with the average diameters in the range of micro to nanometers. The diameter of nanofibers were controlled by various parameters such as polymer and solution properties (viscosity, conductivity, and surface tension), process parameters (applied voltage, velocity of collecting roller, tip-to-collector distance, feed rate of solutions), and ambient conditions (temperature and humidity).[1,2] Many studies have been carried out with above mentioned parameter, however, less attention has been given to solvent properties (conductivity, dipole moment, and boiling point) of polymer solutions.[3]

In this study, PVAc solutions were prepared from eight different kinds of solvent and adjusted to have constant viscosity of 100 ± 10cps. The effects of solvent properties on electrospinnablity of the PVAc solution and fiber diameter of the obtained PVAc fibers were qualitatively observed by scanning electron microscope (SEM).

2. Experimental

2.1. Materials

Poly(vinyl acetate)(PVAc, Mw = 140,000, 500,000, Aldrich), acetonitrile, acetone, metanol, methyl ethly ketone(MEK), toluene, 1,4-dioxane, tetrahydrofuran(THF), and *N,N'*-dimethyl formamide(DMF) were used as received without further purification.

2.2. Methods

PVAc (viscosity 100 ± 10 cps) solutions were prepared from eight kinds of solvent at room temperature. Each of the as-prepared solutions was stocked in a plastic syringe equipped with a high voltage power supply (CPS-60, K02v1, Chungpa EMT Co., Korea) is used as a source of electric field. Electrospinning was performed at 15 kV of supply voltage, 13 cm of tip to collector distance and feeding rate of 5 ml/hr.

3. Results and Discussion

Among the eight different solvents, five different PVAc solutions were found to be highly spinnable with uniform diameter as shown in Figure 1. These five solvents have higher value of dipole moment than others. The boiling point of these solvents are as follows: DMF (153℃) > Acetonitrile (81.6℃) > MEK (79.5℃) > MeOH (64.6℃) > Aceton (56℃). Presumbly, with increasing boiling point the rate evaporation of solvent is slow, which allows droplet to stretch more uniformly. With our optimized conditions the average diameter of different solutions were found to have following trend: DMF (178 nm) < Acetonitrile (535 nm) < MEK (948 nm) < MeOH (1080 nm) < Aceton (1265 nm).

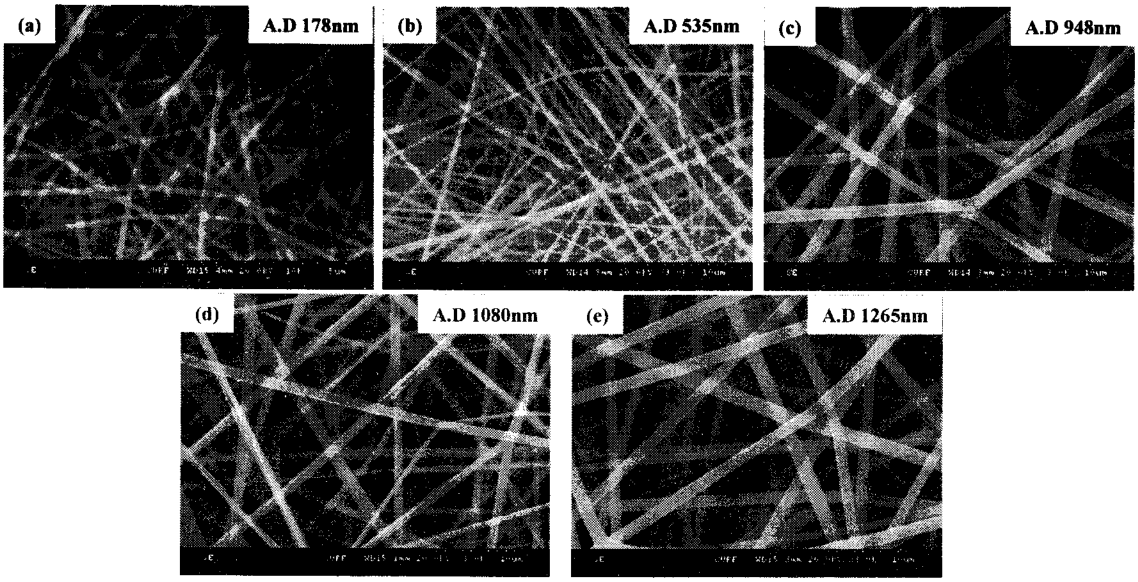

Figure. 1. The SEM images of PVAc nanofiber prepared from different solvents; (a) DMF, (b) Acetonitrile, (c) MEK, (d) MeOH, and (e) Acetone.

4. Conclusion

The results show that the morphology of electrospun nanofibers depend on solvent properties such as dipole moment, dielectric constant and boiling point. Especially, the dipole moment has an effect upon electro-spinnability. The solvent with high boiling point were found to produce thinner fibers..

5. Acknowledgement

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6. References

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