Dependency of particle size on filtration mechanisms of nanofiber web

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Keywords: nanofiber, polyurethane, diffusion, interception
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Aerosol filtration, especially fibrous filtration is quite useful in various industrial fields such as air cleaning and particle sampling due to its simple structure and low cost. Conventional filtration theory reveals that filtration efficiency can be improved by decreasing fiber diameter. Finer fibers lead higher collection efficiency of particle due to diffusion and interception (Hinds, 1999). Therefore, many researchers made efforts to fabricate nanofibers with various methods in order to use filter media.

In the recent years, a good alternative to fabricate nanofibers is electrospinning, which has received considerable attention, due to its simplicity and applicability (Yun *et al*, 2010). Various polymers have been successfully used in the fabrication of nanofibers by electrospinning for past few years. However, electrospun filter media using polyurethane which has excellent mechanical properties (tensile strength, durability, elasticity and water insolubility) (Sheikh *et al*, 2011) were not challenged yet. In addition, it is necessary to investigate the filtration performance of ultrafine particles and collection mechanisms of electrospun filter media. Therefore, polyurethane nanofibers were prepared by electrospinning and the effect of processing parameters such as polymer concentration, electric field and tip to collector distance on fiber morphology were investigated in this study. Furthermore, the filtration performance of ultrafine particles and collection mechanisms were examined.

We found that the fiber formation and morphology is extremely influenced by polymer concentration, electric field and less influenced by tip to collector distance. We could make nanofibers with 100~200 nm in diameter at polymer concentration of 10 wt%, electric field of 1.43 kv/cm and tip to collector distance of 7cm. Based on the above results, the electrospun filter media was prepared and Figure 1 shows their morphology and fiber size distribution.

The fabricated filter media had minimum collection efficiency at the particle size of 80 nm. In general, conventional filter media has minimum collection efficiency at the particle size range of 100 nm to 300 nm. However, the MPPS (Most Penetration Particle Size) for the filter media was shifted to smaller particle size which is likely to have electrostatic attraction such as electret filter.

In addition, we derived the single fiber efficiency of an electrospun filter using a log-penetration equation and plotted as a function of Peclet number. As a result, interception was a significant mechanism in nanofiber filtration for ultrafine particles. This study shows that electrospinning is an effective method for the fabrication of nanofiber filter which has high filtration performance due to electrostatic force.

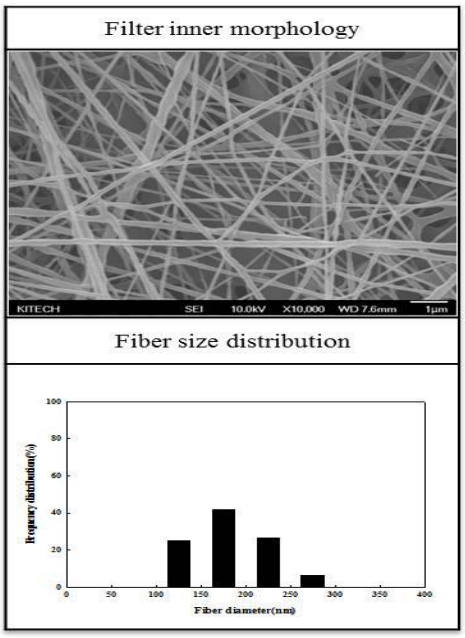

Figure 1. Filter inner morphology and fiber size distribution of electrospun filter media.

This research was financially supported by the eco-innovation project, Republic of Korea (project no.20120001102)

Hinds, W.C. (1999) *Aerosol Technology. Second ed.* Wiley

Yun, K.M., Suryamas, A.B., Iskandar, F., Bao, L., Niinuma, H. and Okuyama, K. (2010) *Sep. Purif. Technol*. **75**, 340-345

Sheikh, F.A., Kanjwal, M.A., Saran, S., Chung, W-.J. and Kim, H. (2011) *Appl. Surf. Sci*. **257**, 3020-3026.