Fabrication and Optimization of Electrospun Porous PLA Nanofiber Membranes for Advanced Filtration Application

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Air pollution has emerged as a critical environmental issue due to rapid industrialization. Particulate matter (PM), a major air pollutant, poses serious health risks as it can lead to respiratory and cardiovascular diseases. This has led to growing demand for high-performance air filtration systems. However, most commercial filters are made of non-biodegradable polymers such PP, PE, and PET, which contribute to environmental pollution during incineration. As a sustainable alternative, polylactic acid (PLA), a biodegradable polymer, has recently gained attention as a promising material for eco-friendly filter applications [1].

Porous fiber structures offer significant advantages in filtration due to their unique morphology. Their large specific surface area provides a greater number of active sites for the physical adsorption of airborne particles [2]. Additionally, compared to conventional smooth-surfaced fibers, porous fibers typically have lower packing density, which reduces air resistance and thus lowers the pressure drop across the filter.

In this study, we fabricated porous PLA nanofiber membranes using the electrospinning process. The pore morphology was controlled by adjusting key processing parameters such as solvent ratio, applied voltage, and humidity. The resulting porous PLA membranes exhibited higher surface area and broader pore size distribution than their smooth counterparts, leading to superior filtration performance. These results indicate that the porous PLA filters are expected to be applied as eco-friendly and high-performance filtration materials.

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