EFFECT OF PORE SIZE ON GAS RESISTANCE OF NANOFIBER MEMBRANE BY THE BUBBLE ELECTROSPINNING

by

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Original scientific paper
DOI: 10.2298/TSCI1504349S

This paper explores the influence of pore size on gas resistance by comparing micron non-woven and nanofiber membrane. The result shows that membrane with a higher filtration and lower gas resistance can be received by controlling the pore size of nanofiber membrane.

Key words: *the bubble electrospinning, pore size, gas resistance, nanofiber membrane*

Introduction

Nanomaterials can improve the surface reactivity for gas filtration [1]. Nanofiber membrane has a higher filtration performance than micrometer non-woven and has been extensively used on the area of filtration [2]. This paper is to explore the effect of pore size on resistance between micron non-woven and nanofiber membrane by the bubble electrospinning. It was found that nanofiber membranes with hierarchical structure have both high filtration efficiency and excellent air permeability [3], the properties are very much suitable for filtration. This paper presents results of our further study of the effect of pore size on filtration.

Experiment

In this paper, polyvinyl alcohol (PVA) is dissolved into deionized water with the temperature 90 °C until a transparent solution is obtained and then the solution is cooled to the room temperature. In the bubble electrospinning [4, 5], the PVA concentration is 7 wt.%, the voltage applied is maintained at 30 kV and the distance between the surface and collector is 25 cm. The diameter and pore size of sample is measured by scanning electron microscopy (SEM) and Porometer 3G.

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Various samples are used in our experiment. Samples 1 to 5 are micron non-wovens in different weight provided by the same factory, as shown in tab. 1, and samples 6 to 12 in tab. 2 are nanofiber membranes obtained with different spinning periods and base fabrics.

Table 1. The parameters of micron non-wovens

Sample	1	2	3	4	5
Weight [gm^{-2}]	20	25	30	40	50
Average diameter [nm]	1695	1564	2033	2520	14830
Average pore size [μm]	24.2	22.0	19.4	13.4	10.8

Table 2. The parameters of nanofiber membranes

Sample	6	7	8	9	10	11	12	13
Spinning time [min]	15	20	5	10	15	20	30	35
Base fabric [gm^{-2}]	30	30	10	10	10	10	10	10
Average diameter [nm]	222	235	258	238	236	177	191	183
Average pore size [μm]	5	2.75	2.26	2.11	2.08	1.58	1.48	1.27

The morphology of the bubble electrospinning is observed with SEM, S-4800, Hitachi, Tokyo, Japan. The comparison between micron non-woven (fig. 1) and nanofiber membrane (fig. 2) is also presented.

The resistance is measured by automatic filter tester 8130 and the relationship between resistance and pore size of micron non-woven and nanofiber membrane by the bubble electrospinning is presented in fig. 3.

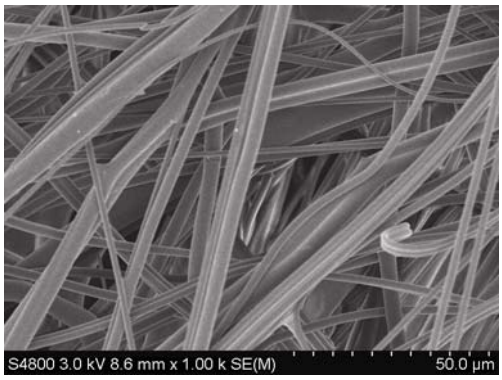

Figure 1. The morphology of micron non-woven

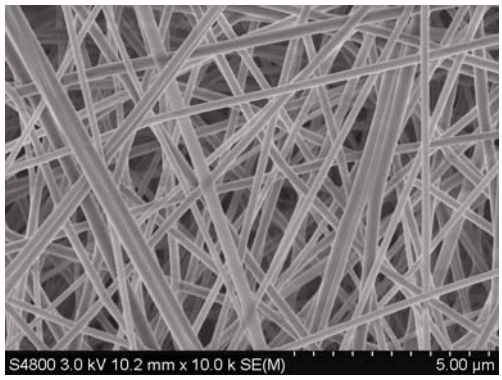

Figure 2. The morphology of nanofiber membrane

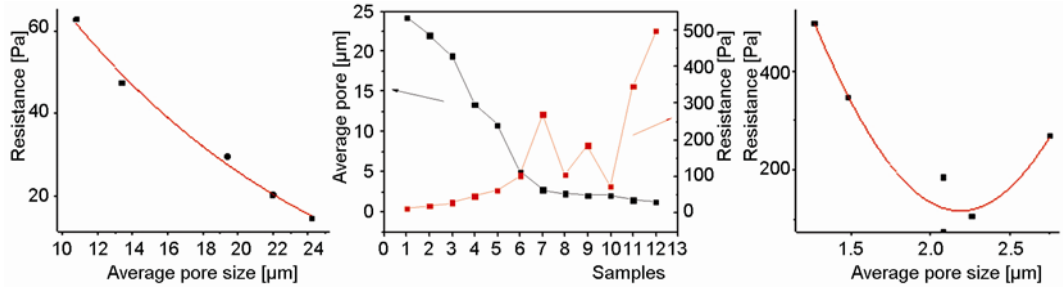

Figure 3. Resistance *vs.* pore size

Results and conclusions

Figure 3 shows that the resistance of micron non-woven increases with the decrease of pore size, however, for nanofiber membrane, this is a minimal resistance when the pore size is between 2.0 micrometers to 2.5 micrometers, *i. e.*, samples 8 and 9 result in minimal resistance though the thickness of nanofiber membrane of sample 9 is twice thicker than that of sample 8. This phenomenon can be explained by hierarchical structure. When pore size tends to micro/nano scales, the resistance depends mainly on pore size and its hierarchical structure.

Acknowledgment

The work is supported by Priority Academic Program Development of Jiangsu Higher Education Institutions (PAPD), National Natural Science Foundation of China under grant No. 61303236 and No. 11372205 and Project for Six Kinds of Top Talents in Jiangsu Province under grant No. ZBZZ-035, Science & Technology Pillar Program of Jiangsu Province under grant No. BE2013072.

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Paper submitted: January 10, 2015
Paper revised: May 5, 2015
Paper accepted: May 12, 2015