A MELT BLOWING-ELECTROSPINNING APPROACH TO FABRICATING NANOFIBERS

by

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Short paper
DOI: 10.2298/TSCI1603010C

A polymer drawing model for melt blowing-electrospinning is established. The fiber diameters are predicted and measured. The results show that the predicted diameters show good agreements with the measured diameters. Fibers fabricated with electrospinning are finer than those without electrospinning, giving a new way to the mass production of nanofibers.

Key words: *melt blowing, electrospinning, polymer drawing, nanofiber*

Introduction

Melt blowing is well known for the mass production of superfine fiber non-wovens. However, it is difficult for the conventional melt blowing technique to fabricate nanofibers. Electrospinning is a common method for fabricating nanofibers but usually with a poor output. If the melt blowing technology can be combined with electrospinning, it is hopeful to produce nanofibers with a considerable output. In this paper, a melt blowing equipment is modified by adding an eletrospinning device. The melt blowing die is connected with the positive electrode of a high voltage electrostatic generator and the collector is set earthed. The fiber diameters are predicted, measured, and compared with fiber diameters of conventional melt blowing.

Results and discussion

The polymer melt is considered as a system of beads connected by viscoelastic elements. The established polymer drawing model [1] is modified by adding a coulomb force and an electric field force to the momentum equation:

$$m_\mathrm{i} \frac{\mathrm{d}u_\mathrm{i}}{\mathrm{d}t} \quad Fr_\mathrm{u,i} \quad Fr_\mathrm{l,i} \quad Fd_\mathrm{i} \quad Fs_\mathrm{i} \quad m_\mathrm{i} g \quad Fc_\mathrm{i} \quad Fe_\mathrm{i} \tag{1}$$

where m_i is the bead mass, $Fr_\mathrm{u,\,i}$ and $Fr_\mathrm{l,\,i}$ – the rheological forces acting upon bead i by the upper and lower elements, respectively, Fd_i – the air drawing force, Fs_i – the surface tension, g – the gravitational acceleration, Fc_i – the coulomb force, and Fe_i – the electric field force.

Non-woven fabrics are fabricated on the melt blowing equipment with and without the eletrospinning device and fiber diameters are predicted and measured. Table 1 shows the fiber diameters fabricated on the melt blowing equipment with and without the electrospinning de-

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Table 1. Fiber diameters fabricated with and without the electrospinning device

No.	Predicted diameter with electrospinning [nm]	Measured diameter with electrospinning [nm]	Prediction error [%]	Diameter without electrospinning [μm]	Diameter reduction [%]
1	408	451	9.53	1.42	68.2
2	799	875	8.69	2.59	66.2
3	783	859	8.85	2.51	65.8
4	924	996	7.23	2.78	64.2
5	313	347	9.80	1.16	70.1

vice. It can be found from the table that the minimum prediction error is 7.23% and the maximum is 9.80%. The mean prediction error is 8.82% showing the predicted fiber diameters tally well with the measured fiber diameters, which confirms the effectiveness of the polymer drawing model established in this paper. Moreover, fiber diameters fabricated on the melt blowing equipment with the electrospinning device are more than 64% smaller than those without the electrospinning device and reach nanoscale.

Conclusion

An eletrospinning device is added to a melt blowing equipment. A polymer drawing model for melt blowing-electrospinning is established. The fiber diameters are predicted, measured, and compared with fiber diameters fabricated without the electrospinning device. The results show that the predicted diameters show good agreements with the measured diameters, which confirms the effectiveness of the established polymer drawing model. Fibers fabricated with electrospinning are finer than those without electrospinning, which gives a new way to the mass production of nanofibers.

Acknowledgment

The work is supported by NSFC under Grant No. 51303121, SRFDP under Grant No. 20123201120015, China Postdoctoral Science Foundation under Grant No.2015M571808, Jiangsu Planned Projects for Postdoctoral Research Funds under Grant No. 1501005A, Project for Jiangsu Scientific and Technological Innovation Team and PAPDJHEI.

Reference

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Paper submitted: December 18, 2015
Paper revised: February 6, 2016
Paper accepted: February 10, 2016