NANOPARTICLES FABRICATED BY THE BUBBLE ELECTROSPINNING

by

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Short paper
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The bubble electrospinning is used to produce nanoparticles from several nanometers to several hundred nanometers in diameter. Silk fibroin aqueous solution with low concentration is used in the experiment. The spinning process can be well controlled by temperature.

Key words: *bubble-electrospinning, silk fibroin, nanoparticles*

Introduction

Electrospinning technique [1] has been extensively developed for fabricating nanofibers with well-controlled sizes, compositions, and morphologies. In addition, the bubble-electrospinning has received an increasing attention due to its high-throughput [2] used in applications that include reinforcement of composite materials, ultrafiltration, tissue engineering, as well as the fabrication of sensors, batteries, and other types of devices. In this paper, a low concentration silk fibroin aqueous solution is carried out by the bubble-electrospinning for fabrication of nanoparticles.

Experimental

Raw silk was degummed three times with 0.5% (w/w) Na_2CO_3 solution at 100 °C for 30 min, and then washed with distilled water. Degummed silk fibroin (SF) was dissolved in 9.3 mol/L LiBr solution. After dialysis in cellulose tubular membrane (molecular weight cutoff = 8000～14000, Sigma, USA) against distilled water for 3 days and filtration, the final SF aqueous solution with concentration about 3.5% was obtained.

The aqueous SF solution was heated and concentrated at temperature 45 °C in order to acquire the concentration 10% used in this study. The prepared SF solution was used in the bubble electrospinning process. The applied voltage is 16 kV and the distance between nozzle and collector is 10 cm, fig. 1.

The morphology of electrospun nanoparticles, fig. 2, were observed with scanning electron microscopy (SEM, S-4800, Hitachi, Tokyo, Japan) at 20 °C and 60% relative humidity.

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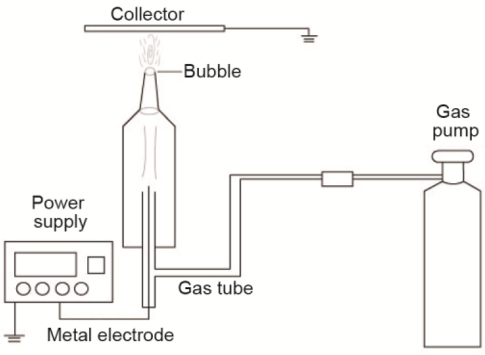

Figure 1. Experimental setup

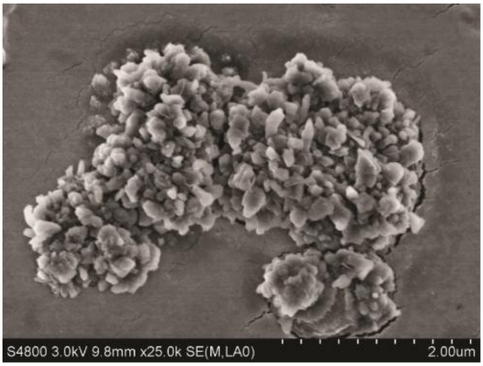

Figure 2. Scanning electron micrograph

In fig. 2, excessive amount of nanoparticles were gathered together to form a large fragment. The particles diameter ranged from several nanometers to several hundred nanometers, which enhanced the high surface area to volume.

Conclusions

Because of ultra improvement of the high specific surface, the fragment-like nanoparticles are potentially of great technological interest for the development of electronic, catalytic and hydrogen-storage systems, invisibility device (*e. g*. stealth plane), photonic structures, sensors, medicine, pharmacy and drug deliver, and others. Far-reaching implications are emerging for applications including radiation protection, medical implants, cell supports, materials that can be used as instructive 3-D environments for tissue regeneration and others. The morphology of the nanoparticles is adjustable by the temperature [3].

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References

[1] Li, D., *et al.*, Use of Electrospinning to Directly Fabricate Hollow Nanofibers with Functionalized Inner and Outer Surfaces, *Small, 1* (2005), 1, pp. 83-86
[2] Yang, R. *et al.*, Bubble-Electrospinning for Fabrication of Nanofibres with Diameter of about 20 nm, *Int. J. Nonlin. Sci. Num., 11* (2010), Suppl., pp, 163-164
[3] He, J. H., Effect of Temperature on Surface Tension of a Bubble and Hierarchical Ruptured Bubbles for Nanofiber Fabrication, *Thermal Science, 16* (2012), 1, pp. 325-328

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