Stduy on Aluminium Oxide Nanofibers Via Electrospinning

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Abstract: The spinning solutions of aluminium nitrate/PVA which were prepared by sol-gel process using aluminium nitrate, poly (vinyl alcohol) (PVA) and water as materials were electrospun into aluminium nitrate/PVA organic-inorganic hybrid fibers. Aluminium oxide nanofibers were obtained with diameters of 50 ~ 250 nm after calcinations.

Key words: electrospinning; aluminium oxide; nanofiber; calcination
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Alumium oxide fiber has common characteristics such as high heat resistance, high electrical insulation, excellent wear resistance. Because of its excellent properties, alumina has become one of the most popular inorganic fiber materials, and more and more scholars were attracted to pay attention to studying on aluminium oxide fiber[1-2].

However, it is well known that alumina is usually very difficult to form into a fibrous state, especially nanoscale fibers. Among all the routes to produce nanoscale fibers, electrospinning is recognized as one of the simple and versatile processes, through which continuous nanofibers from a huge range of materials, including polymers, composites and ceramics with tunable diameter can be fabricated[3-6]. The objective of the present in vitro study was to prepare aluminium oxide nanofibers by a new spinning technology—electrospinning.

1 Experimental

1.1 Materials

Poly (vinyl alcohol) (PVA, $M_n = 80\ 000$) was purchased from Shanghai Chemical Co., LTD. Aluminium nitrate was obtained from Tianjin No.3 Chemical regent Plant. Distilled water and ethanol supplied by Tianjin motian membrane Eng. & Tech Co., Ltd and Tianjin No.1 Chemical regent plant respectively was used as a solvent without further purification.

1.2 Preparation of aluminium oxide nano fibers

PVA was first dissolved in 90℃ water to get aqueous solutions with different concentration. 2.0 g of aluminium nitrate dissolved in 2.0 g water were subsequently dropped slowly into the as-prepared PVA solution separately which were then kept in 60 ℃ water bath for 4 h and followed by addition of 10 mL ethanol. Thus, the viscous sol-gel spinning solutions of aluminium nitrate/PVA were obtained and electrospun into aluminium nitrate/PVA organic-inorganic hybrid fibers which were dryed in a vacuum oven at 90 ℃ for 24 h and then were calcinated in muffle at 500 ℃ and 1 000 ℃ for 5 h in air to get pure aluminium oxide nanofibers.

1.3 Characterization

The morphology of the resulting nanofibers was observed on a scanning electron microscope (FEI QUANTA200 USA) after gold coating. The average diameter was obtained by using adobe imageready CS software to analyze the SEM images.

2 Results and Disscussion

2.1 Aluminum nitrate/PVA hybrid fibers

In the spinning solutions, aluminum nitrate was the precursor of the alumina, and PVA was served as polymeric matrix to hold aluminum nitrate and also to provide the solution spinnability. By adjusting the viscosity and surface tension of the spinning solution, aluminum nitrate/PVA organic-inorganic hybrid fibers

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could be obtained. As shown in Fig.1.

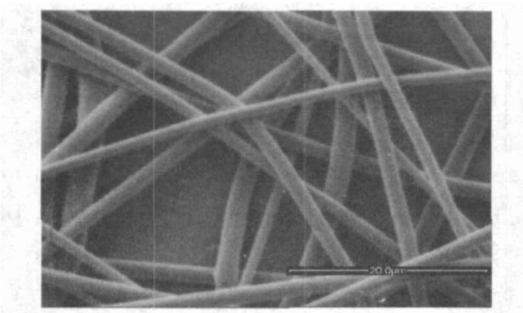

Fig.1 SEM Photograph of aluminum nitrate/PVA fibers (w=10%)

2.2 Influence of concentration of spinning solution

Through fixed other parameters and reduced concentration of spinning solution, much finer fiber could be gained more easily, as shown in Fig.2. Because the viscosity and surface tension of spinning solution at the low concentration was much less correspondingly, thus lower electrostatic force was needed to overcome surface tension of spinning solution during electrospinning process so that the polymer was much easier to be drawn.

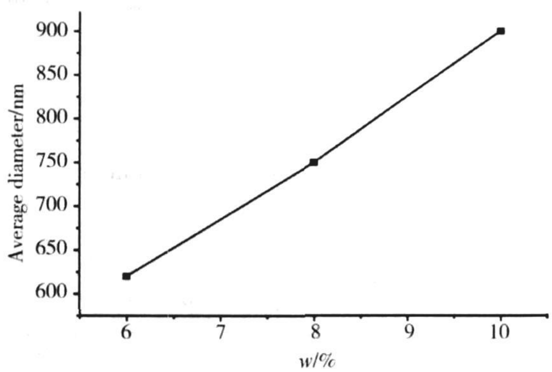

Fig.2 Relationship between concentration of spinning solution and average diameter of nanofibers

2.3 Effect of calcinations temperature

SEM photographs of the aluminium oxide fibers sintered at different temperatures for 5 h were presented in Fig.3. It can be seen that the diameter of the fibers becomes smaller than the as-prepared aluminum nitrate/PVA fibers in Fig.1 after calcinations at 500 ℃ because of the decomposition of aluminium nitrate and PVA. When the calcinations temperature reached to 1 000 ℃, the diameter of aluminium oixde fibers decreased further about 50 ~ 250 nm, which indicated that most of the organic groups were removed.

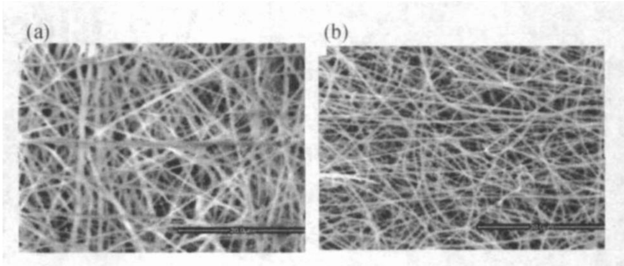

Fig.3 SEM photographs of the aluminium oxide fibers sintered at different temperatures:
(a) w=10%, 500℃; (b) w=10%, 1 000 ℃

3 Conclusion

In this work, aluminium oxide nanofibers with diameters of 50 ~ 250 nm were prepared by using the electrospun organic-inorganic hybrid fibers of aluminium nitrate/PVA as precursor followed by calcinations. This technique might provide a way for preparing nanofibers of inorganic materials in a simple and inexpensive method.

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聚丙烯腈基活性碳纤维毡的制备及性能研究

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摘　要：研究了聚丙烯腈基活性碳纤维毡的制备及实验装置的研究，并用碘吸附值和苯吸附值对聚丙烯腈基活性碳纤维的性能进行了测试，并得出了实验的最佳工艺，通过对最佳工艺制得的活性碳纤维的比表面积、孔容和孔径的测试。我们得出以下结论：比表面积为 1 686 m^2/g，孔容为 0.55 mL/g，孔径为 0.65 nm。

关键词：PAN-ACF；碳化；研究

中图分类号：TQ432.74

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静电纺氧化铝纳米纤维研究

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摘　要：采用溶胶—凝胶法，以聚乙烯醇、硝酸铝、水为原料配制出了硝酸铝/聚乙烯醇溶胶—凝胶纺丝液，并通过静电纺丝技术纺制了 $Al(NO_3)_3$/PVA有机—无机杂化纤维，经高温锻烧后得到了平均直径约为 50～250 nm无机纳米氧化铝纤维。

关键词：静电纺丝；氧化铝；纳米纤维；煅烧

中图分类号：TQ343.5