Synthesis and cytotoxicity of size-controlled mesoporous silica nanoparticles

Kexin Qiu[a,b], Wei Feng[a], Xiumei Mo[a,b], Chuanglong He[a,*]
[a]College of Chemistry, Chemical Engineering and Biotechnology, Donghua University, Shanghai 201620, China
[b]College of Materials Science and Engineering, Donghua University, Shanghai 201620, China
E-mail address: hcl@dhu.edu.cn (C. He).

The cytotoxicity of mesoporous silica nanoparticles (MSNs) has recently received increasing attention because particle size can affect the efficiency of cellular uptake when MSNs were used as targeted carrier [1]. In this study, we synthesized three kinds of size-controlled MSNs by controlling the relative addition rate (9 mL/6 h, 9 mL/12 h and 9 mL/18 h) of silica source (tetraethylorthosilicate, TEOS) in neutral environment. Furthermore, we investigated the effects of MSNs on HeLa cells by the standard 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide (MTT) assay.

Fig. 1A) a–c show that longer time interval of TEOS addition leads to the improvement of the sphericity and dispersivity of MSNs, which may be attributed to the fact that the longer time interval of TEOS addition allows a better growth MSNs. Besides, as depicted in Fig. 1A) d–f, the mean particle size of MSNs increased from 172.06 nm (±17.56 nm) to 418.58 nm (±84 nm) and then reduced to 344.07 nm (±20.42 nm) with the decrease of relative addition rate of TEOS. Fig. 1C) illustrates that the SAXRD diffraction peaks become narrower and stronger when the relative addition rate of TEOS increased, which indicates that MSNs with well-ordered pore structure can be obtained at the relative addition rate of 9 mL/18 h. In addition, the N_2 adsorption–desorption isotherms and pore size distributions by the Barrett–Joyner–Halenda (BJH) method (Fig. 1B) also demonstrate that MSNs possess highly uniform pores and similar pore size distribution curves. Fig. 1D shows the size- and concentration-dependent effects of MSNs on HeLa cells. The MSNs with smaller particle size and higher concentration exhibit higher cytotoxicity. In summary, size-controlled and well-ordered MSNs were successfully prepared. The prepared MSNs show size- and concentration-dependent cytotoxic effects on HeLa cells, suggesting that the larger MSNs may be the best candidate for future biomedical applications.

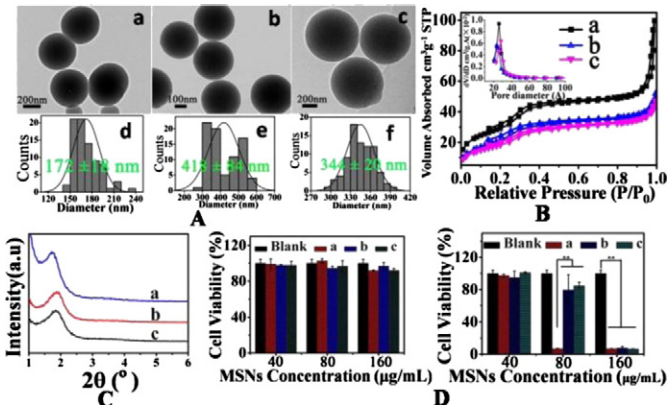

Fig. 1. A) TEM images and particle size distribution of MSNs: (a, d) 9 mL/6 h, (b, e) 9 mL/12 h, (c, f) 9 mL/18 h; B), C) and D) are nitrogen adsorption–desorption isotherms (inset: the pore size distribution), SAXRD and the cytotoxicity of different MSNs (left: 24 h, right: 48 h): (a) 9 mL/6 h, (b) 9 mL/12 h, (c) 9 mL/18 h.

Keywords: MSNs, size-controlled, TEOS, cytotoxicity, HeLa cells

Acknowledgments

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Reference

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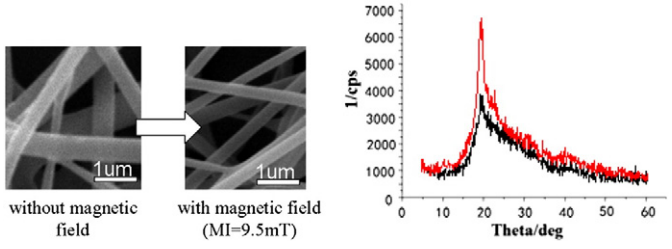
Aligned nanofibers by magnetic-electrospinning for biomedical applications

Lan Xu[a,b,*], Liang Wang[a], Na Si[a], Jihuan He[a,b]
[a]National Engineering Laboratory for Modern Silk, College of Textile and Engineering, Soochow University, Suzhou 215123, China
[b]Nantong Textile Institute of Soochow University, Nantong 226018, China
E-mail address: lanxu@suda.edu.cn (L. Xu).

During the electrospinning process, the collected nanofibers are typically randomly oriented in the form of nonwoven mats. The randomly oriented nanofibers lead to low molecular orientation and as a result materials with low mechanical properties are obtained. It is desirable to generate aligned nanofibers to broaden the applications of electrospinning, such as electronic and photonic devices, tissue engineering, and composite materials. Recently, magnetic-electrospinning has been designed to solve problems with the traditional electrospinning [1]. A mathematical model for magnetic-electrospinning process has been established [2]. In this paper, a new electrospinning set-up coupled with magnetic field initiated by a U-shape electromagnet is devised to prepare aligned nanofibers. The effect of the magnetic field on the diameter and crystallinity of electrospun fibers has been investigated.

Polyvinyl alcohol (PVA), with a degree of polymerization of 175050, was dissolved in deionized water with a weight ratio of 10%. The obtained solutions were electrospun under different magnetic intensities. The morphology of the electrospun nanofibers was investigated by Scanning Electron Microscopy (SEM). The crystallinity of the PVA nanofibers was determined by an X-ray Diffractometer (XRD). The results showed that the new electrospinning set-up can be used to produce relatively well-aligned nanofibers with small diameter. In addition, the crystal peaks of electrospun nanofibers became sharper when the magnetic intensity was increased. This offers promising perspectives for the application of magnetic-electrospinning.



Scheme 1. The effect of magnetic field on electrospun fibers (in the X-ray diffraction patterns: black line — without magnetic field, red line — with magnetic field (MI = 9.5 mT)).

Keywords: magnetic field, electrospinning, crystalline

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