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Degradable polyvinyl alcohol/poly(butylene carbonate) core–shell nanofibers for chemotherapy and tissue engineering

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ABSTRACT

Polyvinyl alcohol/poly(butylene carbonate) (PVA/PBC) core–shell nanofibers are successfully prepared by the coaxial electrospinning technology, in which PVA forms the core and PBC forms the shell. The core–shell microstructure of the fibers is certified by transmission electron microscopy (TEM). FT-IR analysis demonstrates that there is no chemical interaction between PVA and PBC. The as-prepared nanofibers are completely biocompatible and they can be used as a drug loader for doxorubicin (DOX). The DOX loaded nanofibers are quite effective in prohibiting the SKOV3 ovary cells attachment and proliferation, which are potential for chemotherapy of ovary cancer. Besides, the PVA/PBC core–shell nanofibers can be degraded in physiological environment, which is promising in the application of tissue engineering.

1. Introduction

Coaxial electrospinning, as a development of electrospinning method, has been paid extensive attention during the last few years [1–4]. This method is capable of synthesizing a continuous double layer of nanofibers by co-electrospinning two materials through a facile one-step procedure. The core–shell fiber mat made through coaxial electrospinning can exhibit advantageous characteristics from both of the constituent materials. Recently, much attention has been given to the fabrication of the core–shell nanofibers using the biomaterials, which can provide a feasible route for a better loading and controlled release of some chemicals and drugs [5,6]. Especially the core–shell nanofibers made from the degradable biomicromoleculars, have received particular interest due to their potential applications in biomedical field [7,8].

In the present paper, two degradable polymers polyvinyl alcohol (PVA) and poly(butylene carbonate) (PBC) were chosen to construct the PVA/PBC core–shell fibers. The as-prepared nanofibers are completely biocompatible and they can be used as a drug carrier for DOX. The DOX loaded fibers exhibit excellent performance in prohibiting the SKOV3 ovary cells attachment and proliferation. Besides, after cultured with the cells for a determined time, the resulting fibers were well degraded. These PVA/PBC core–shell fibers are promising in the applications of chemotherapy and tissue engineering.

2. Experimental

PVA (Dp = 1750) was supplied by Changchun Institute of Applied Chemistry Chinese Academy of Science (China). PBC, DOX and DMF were used as received.

Preparation of PVA/PBC core–shell nanofibers was conducted according to reference [9]. 7 wt% PVA aqueous solution was used as the core material and 15 wt% PBC/DMF solution was used as the shell material. The coaxial spinneret contained two concentrically arranged capillaries. PVA and PBC solutions were loaded in two individual syringe connected to the inner and outer capillaries of the coaxial spinneret. The flow rate of solutions in the capillaries was adjusted by a pump with two separate systems. Both capillaries were connected to a high voltage power supply. Aluminum foil and copper net were used as the collector for the fibers. The applied voltage was 18 kV and the distance was 25 cm. The flow rate of PVA was fixed at 1 mL h^{-1}, and the flow rate of PBC was set to be 0.7, 1.0 and 1.3 mL h^{-1}, respectively. That is, the feed ratio between PVA and PBC was 1:0.7, 1:1 and 1:1.3. For the DOX loaded PVA/PBC nanofibers, DOX was dissolved into the PVA solution. The

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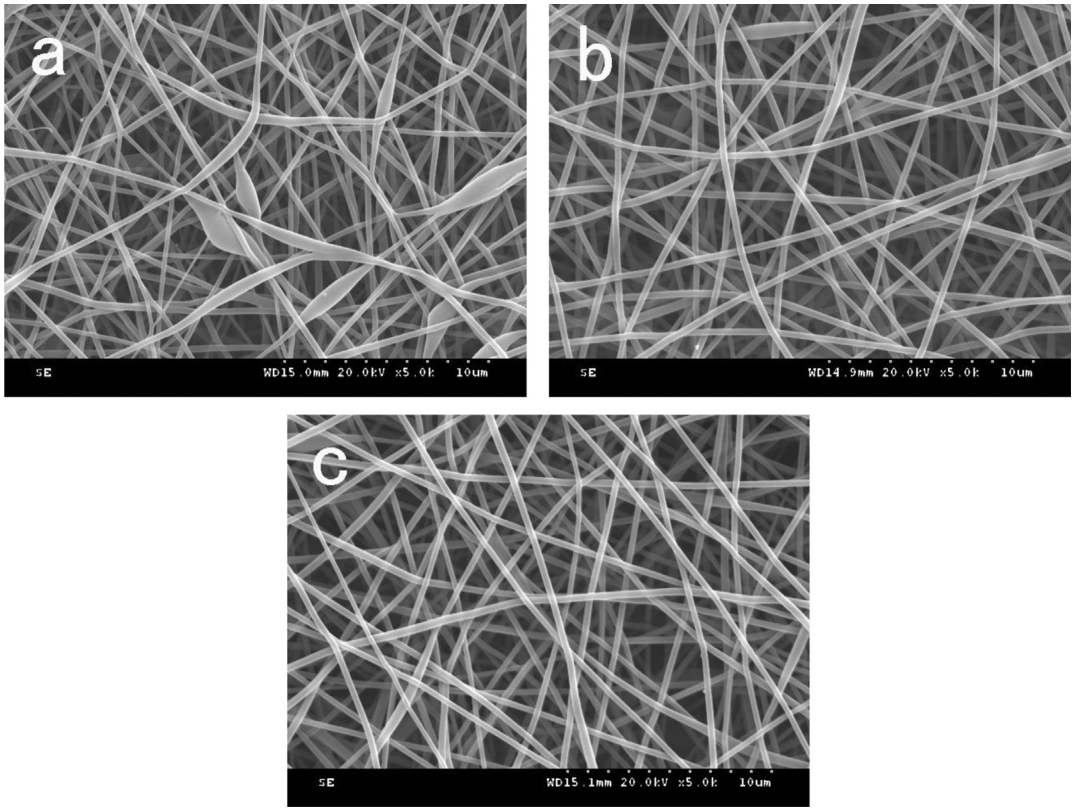

Fig. 1. SEM images of PVA/PBC core–shell composite nanofibers with different feed ratios of 1:1.3 (a), 1:1 (b) and 1:0.7 (c).

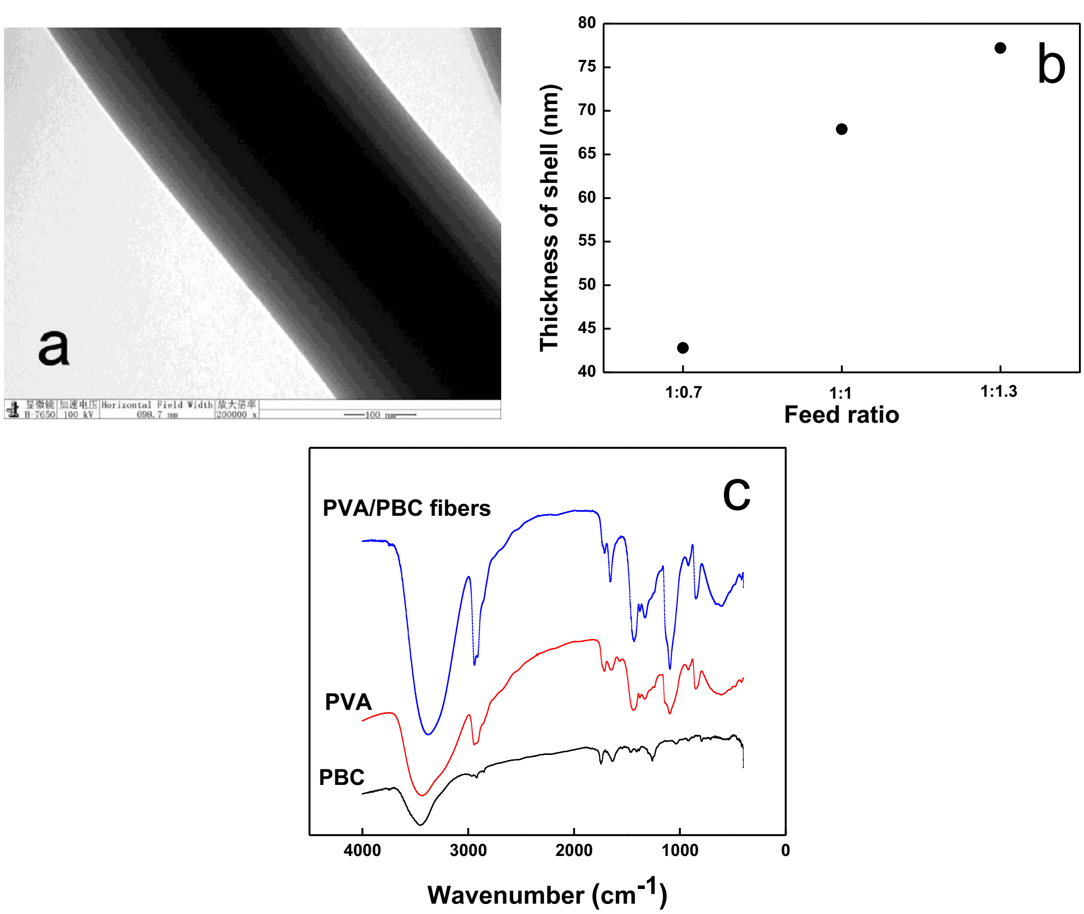

Fig. 2. TEM image of PVA/PBC core–shell composite nanofibers with the feed ratio of 1:1 (a), the feed ratio versus the thickness of fiber's shell (b) and FT-IR spectra of PVA, PBC and PVA/PBC core–shell nanofibers (c).