Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information

High-water-absorbing calcium alginate fibrous scaffold fabricated by microfluidic spinning for use in chronic wound dressings

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1. Characterization

1.1 Fluorescence inverted microscope

The different velocities of solution affect in microfluidic technique the morphologies of fibers which were examined by Fluorescence inverted microscope (OLYMPUS- IX73, Olympus Co., Japan). The morphologies of the Ca-Alg fibers were hardly affected by the different velocity. However, the diameter of Ca-Alg fibers would increase as the velocity of the Na-Alg solution increase (Figure S1 and Figure S2), on the contrary, the diameter would reduce as the velocity of the $CaCl_2$ solution increase (Figure S3 and Figure S4). It is easy to understand that the larger the flow of Na-Alg solution, the larger the diameter of the Ca-Alg fibers. And as the the velocity of the $CaCl_2$ solution increases, the initial shear rate of the fluid increases, and the shear stress increases, the extent and scope of the diffusion of Na-Alg solution decreases. Calcium ions enter Na-Alg solution to undergo ion cross-linking reaction, and the diameter of Ca-Alg fibers finally decreases.

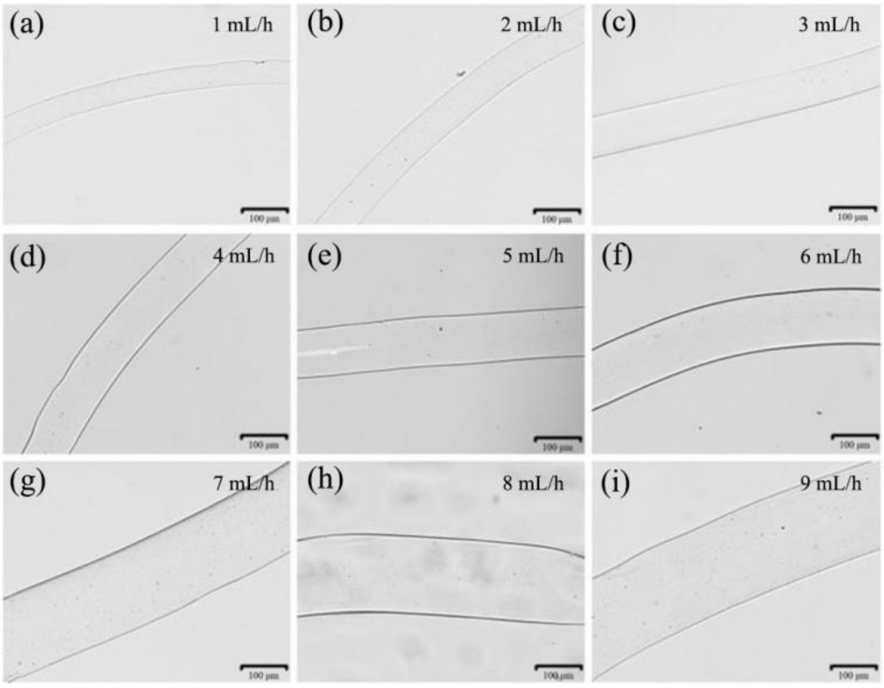

Figure S1 The morphology of Ca-Alg fibers prepared in different velocity of Na-Alg solution. (The bar is 100 μm).

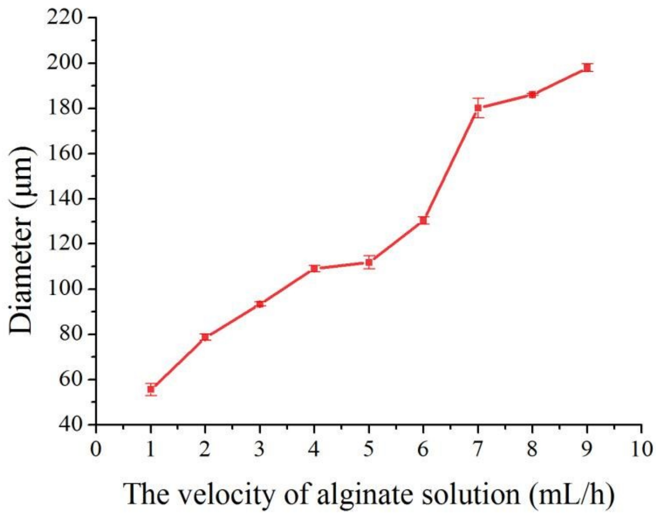

Figure S2 The mean diameter of Ca-Alg fibers prepared in different velocity of Na-Alg solution.

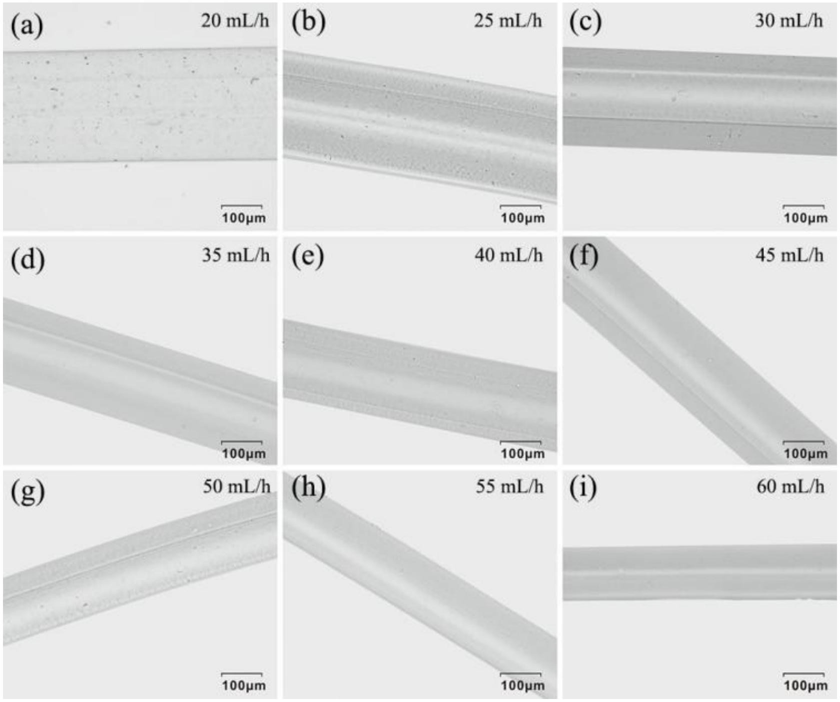

Figure S3 The morphology of Ca-Alg fibers prepared in different velocity of $CaCl_2$ solution. (The bar is 100 μm).

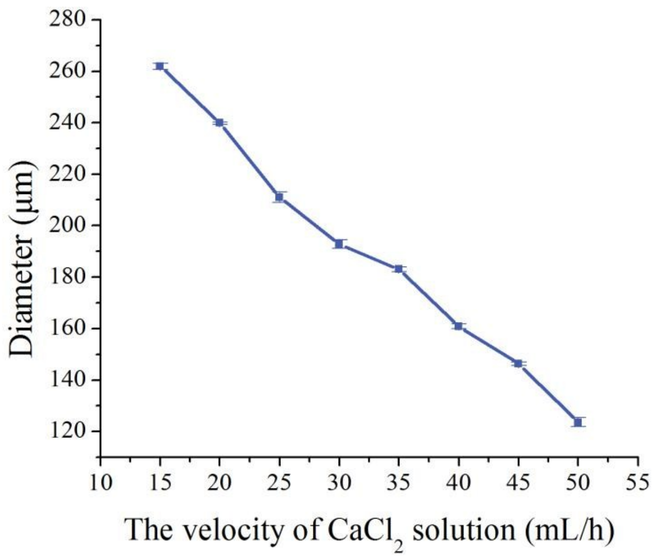

Figure S4 The mean diameter of Ca-Alg fibers prepared in different velocity of $CaCl_2$ solution.

In addition, we measured the changes of fiber diameter after water absorption that demonstrated that the diameter of the dry fibers increased 1.4 times after thoroughly swollen (Figure S5).

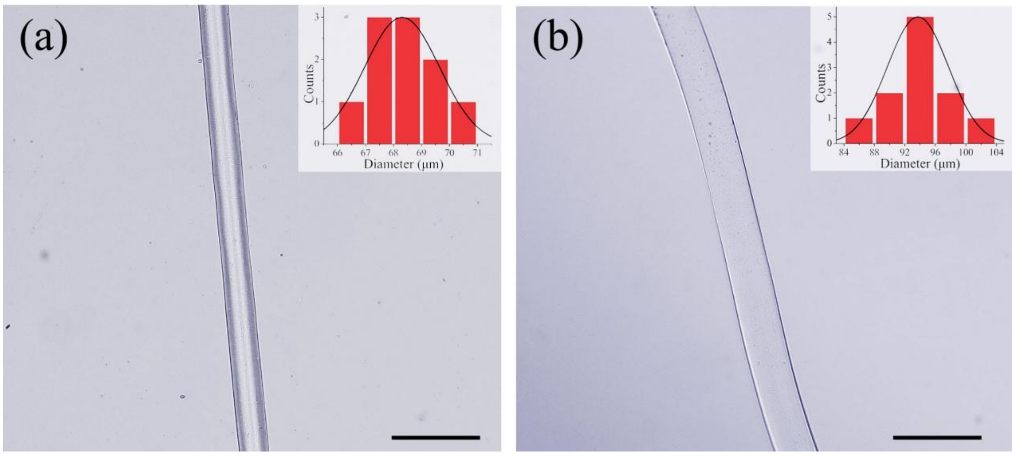

Figure S5 The morphology of Ca-Alg fibers before water absorption (a) and after water absorption (b). (The bar is 200 μm)

1.2 Mechanical integrity

The mechanical integrity of the scaffold which was performed on a universal testing machine (CMT6503, SANS Test Machine Co. Ltd., China) at room temperature with a speed of 2 mm min^{-1}. And the scaffolds were trimmed as cylinder-shaped samples with the size of 10 mm in diameter and 10 mm in height were tested. Besides, all the samples were provided with a uniform load, and the compressive strength was calculated with the linear range of the stress–strain curve. As shown in Figure S6, the compression resistance of the Ca-Alg fibrous scaffold was about 5 MPa, indicating excellent mechanical properties as a kind of wound dressings.

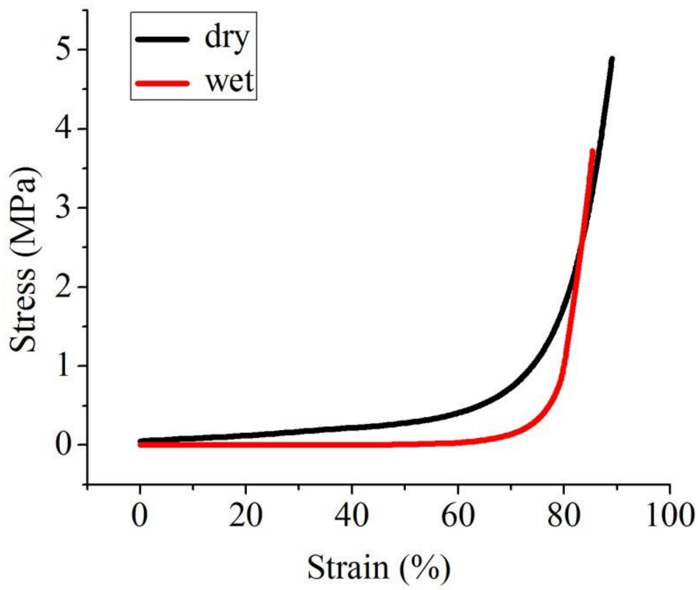

Figure S6 Stress-strain curve for the Ca-Alg fibrous scaffold (dry and wet).

1.3 Biodegradable

The alginate possesses excellent biodegradable in vitro. Considering the fact that calcium alginate (Ca-Alg) fibrous scaffold was designed to be used in chronic wound dressings in this work, we completed an in vitro degradation experiment. The Ca-Alg fibrous scaffolds and the commercial wound dressing No.1 (Alginate dressing, Innomed, Zhejiang longtai medical technology Co. LTD.), the commercial wound dressing No.2 (Alginate dressing, TopMedical, Zhejiang medical ding medical dressing Co. LTD.) and our Ca-Alg fibrous scaffold were added into PBS buffer at 36.2 °C. The samples were incubated and picked up at designed time (1 h, 12 h, and 48 h) to observe the morphology change of samples. The compared experiment results of SEM images were shown in the Figure S7, the Ca-Alg fibrous scaffold (Figure S7 [a] – [d]) exhibited poor permanence of retention characteristic compared with commercial products (Figure S7 [e] – [l]). The degradation speed of our sample was the fastest in all test samples.

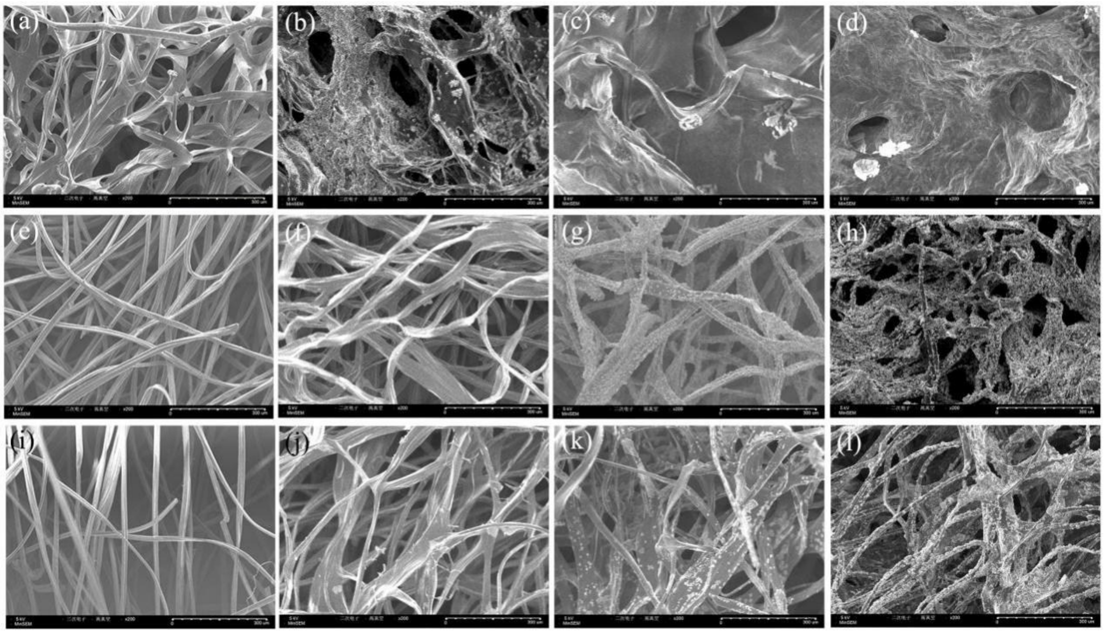

Figure S7 SEM images of materials degradation experiment. (a) – (d) Ca-Alg fibrous scaffolds; (e) – (h) the commercial wound dressing No.1; (i) – (l) the commercial wound dressing No.2; (a), (e), (i) the initial of test; (b), (f), (j); after 2 h absorption in PBS buffer; (c), (g), (k) after 12 h absorption in PBS buffer; (d), (h), (l) after 48 h absorption in PBS buffer.

1.4 The release of Ca-Alg fibrous scaffold silver ions

The Ca-Alg fibrous scaffold was put in a 30 mL-reagent bottle, the 20 mL of PBS buffer was added at room temperature. The 3ml solutions were taken out at 1h, 3h, 6h, 9h, 18h and 24h respectively, and the silver content was measured with an ultraviolet spectrophotometer (UV-3000, Daojin Co. Ltd., Japan). We can see that the silver content increased with time point (Figure S8). That indicated that the antibacterial property is functional through the release of silver ions.

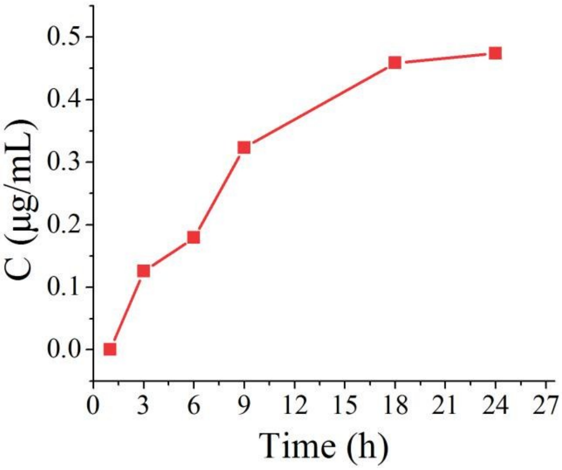

Figure S8 The curve of silver ions release of the Ca-Alg fibrous scaffold loaded with AgNPs.