Poly (aspartic acid) hydrogel nanofibers from electrospun polysuccinimide membranes for controlled release

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Statement of Purpose: Though electospinning is one of the most widely used methods to produce nanofibers from polymer, according to our best knowledge Until to now, there are no studies on electrospinning process studies of PSI and preparation of PASP hydrogel nanofibers via crosslinking of PSI fibrous mat. In view of that, we synthesized the PSI and explored the spinning performance of PSI firstly. The main purpose of this manuscript was to understand how fiber structure was affected by the properties of PSI solutions. Then PASP hydrogel nanofibers were produced by crosslinking and hydrolysis of PSI fibrous mat. The structure, morphology, pore size distribution were investigated by FTIR, SEM and Through-pore Size Analyzer, respectively. And the swelling ratio of PASP hydrogel nanofibers was measured. Doxorubicin was loaded in the nanofibers and its release was investigated.

Methods: Material L-aspartic acid (ASP) and 85% phosphoric acid were purchased from Aladdin Industrial Corporation (Shanghai, China). PSI was prepared in our laboratory according to the literature [1]. N,N-dimethylformamide (DMF), methanol, sodium hydroxide, ethylenediamine were obtained from Shanghai Lingfeng Chemical Reagent Co. Ltd. All the chemicals used without further purification as it obtained. The nanofibrous mat of prepared from 28wt%, 30 wt%, 32 wt%, 34 wt% PSI solution and the according casting films [2] were placed in 1L ethylenediamine saturated steam for 12 hr at 25oC to allow crosslinking occur and then dried under vacuum at 50 ^{o}C for 6 hr. Hydrolysis was conducted in NaOH/water solution at with pH 12 for 0.5 hr. The hydrolyzed membranes were washed with water until neutral and then immersed in methanol to deswelling, followed by dried in a vacuum oven at 40 ^{o}C for 6 hr. Doxorubicin was chosen as the model drugs for their controlled release. The in vitro release was carried out at 37 °C to investigate DOX release profiles.

Results:

The weight-average molecular weight (Mw) and polydispersity (Mw/Mn) (Mn: the number-average molecular weight) of synthetic PSI in this study, measured by GPC, were 31500. The swelling ratio of PASP membranes in distilled water was explored. The water absorption ratio of the PASP electrospun mats varied in range of form 22.5 to 27.3, while the casting film only had a swelling ratio of 4.6 g/g due to lack of pore. The liquid uptake in membranes depended on the liquid of held in the inner pores and that diffused into the fibers. In the electrospun mats with numerous interconnected pores and large surface, the water molecules could easy enter into the pores and diffuse into the fibers, leading to a high swelling ratio.

The swelling ratio of fibrous mats increased with the increasing of fiber size firstly, and then came down. This was mainly attributed to the different of pore size and the fiber diameter.

Table 1 The pore size of PSI and PASP electrospun mats.

Concentration (wt%)	PSI(μm）			PASP(μm）		
	Max	Mean	Min	Max	Mean	Min
28	5.981	3.575	1.538	4.617	0.886	0.597
30	7.298	4.503	2.86	5.569	2.51	0.648
32	15.32	6.803	3.498	5.606	3.193	0.882
34	19.51	7.998	2.436	6.717	4.64	2.046

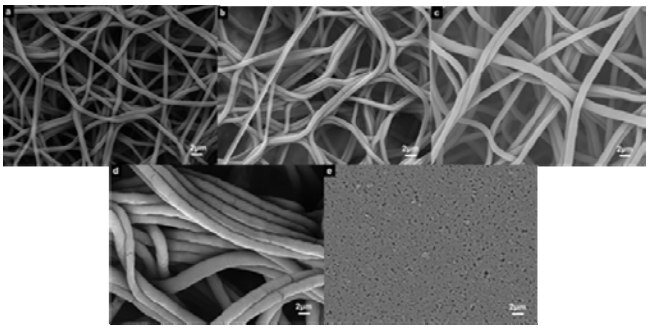

Figure 1. SEM micrographs of PSI membranes after crosslinking. (a) 28wt%, (b) 30wt%, (c) 32wt%, (d) 34wt%, and (e) casting film.

Conclusions: PSI nanofibers were generated from electrospinning of PSI in DMF with the relatively high concentration range from 26wt% to 34wt% due to the relatively low molecular weight. And high concentration of the PSI solution as well as poor electrical conductivity caused the fiber in large diameter. The pore size and fiber diameter in PSI mats increased with the increasing concentration. After crosslinking, the fiber was distorted and lumped together with the fiber size a little larger. With the hydrolysis, the pore size was smaller than that in PSI fibers mat and the membranes became compact. When the membranes were immersed into the water, large deformation occurred because of the flexible backbone of PASP. The water absorption ratio of the PASP electrospun hydrogel with numerous interconnected pores and large surface were much large than casting film. And the water uptake increased with the increasing of fiber diameter firstly, and then came down.

References

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[2] Zhao, Y.; Su, H.; Fang, L.; Tan, T. Polymer 2005, 46, 5368.