새로운 생분해성 아이오너머의 전기방사에 관한 연구

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Electrospinning of the Unique Biodegradable Ionomer

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1. Introduction

In last two decades, biodegradable polyester has been studied extensively due to their biodegradability, biocompatibility and physical or chemical properties in order to replace non-biodegradable polymers that cause environmental problems [1]. One of the most promising biodegradable polyesters, poly (butylene succinate) (PBS) was commercialized but its applications were restricted due to its poorer mechanical properties [2]. To improve its rheological and mechanical properties, poly (butylene succinate) ionomer (PBSi) had been introduced [3]. In addition, it had been reported that PBSi had a great potential for some medial applications [4]. On the other hand, it has been manifested that the electrospinning is an attractive method to fabricate micron to nano sized structures for various polymers which have high specific surface areas [5]. Numerous polymers have been fabricated into nano sized structures by electrospining. Moreover, it has been recently informed the electrospinning of PBS [6]. It is well known that the interconnected porous structure is much more favorable for the biomaterials compared with the film with smooth surface. Therefore, it can be said that the porous PBSi nano-web not only has some possibility as biomaterials but also overcomes some shortcomings of the nonporous structured materials. In this study, we prepared the PBSi with two-step polymerization including esterification and subsequent polycondensation reaction and then fabricated the PBSi nano-web by elctrospinning. As we know, the electrospinning of ionomers has been few reported as well as it is first fabricated the PBSi nano-web by means of electrospinning. The electrospun PBSi nano-web would have great potential to extend its practical usages in multifarious application fields such as filters, catalyses, protecting clothes, implants, and tissue engineering, and so on.

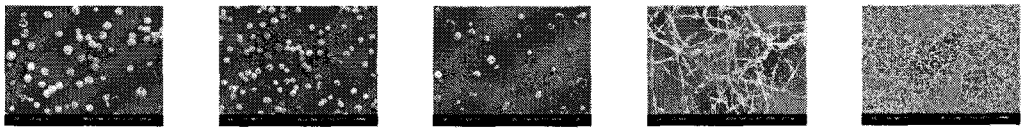
2. Experimental

Succinic acid, 1,4-butanediol, titanium tetrabutoxide, dimethyl fumarate (DMF), sodium hydrogen sulfite ($NaHSO_4$), and chloroform ($CHCl_3$) were purchase from sigma-aldrich and used without further purification. A sodium dimethyl fumarate (SDMF) containing ionic group was synthesized using DMF) and $NaHSO_4$. As mentioned early, we prepared PBSi by two step polymerization including the esterification and polycondensation. The ionomer content of PBSi was adjusted at 1 mol%. PBSi was dissolved in $CHCl_3$ to prepare the solution. With the variation of primary parameters such as concentration of PBSi, and applied voltage, the nano-sized web of PBS

was prepared. The secondary parameters were fixed at 22 G, 20 cm, and 3 mL/h, needle size, distance between tip and collector, and flow rate, respectively. The structure was confirmed with Fourier transform-NMR (300 MHz) spectrometer (Varian, Salt Lake City, UT, USA) with $CDCl_3$ containing tetramethylsilane (TMS) as an internal standard. SEM S-3000N with E-1010, Hitachi was used to investigate the surface morphology of electrospund web.

3. Results and discussion

The PBSi exhibit the new peaks form 3.7ppm to 3.65ppm, which may be attributed to the methine hydrogen in the sulfonated succinate unit for the SDMF. In addition, it can found that the integration ratio between the signal at SDMF peaks (peak X) and the resonance at 2.6ppm for the methylene hydrogens (-$OCOCH_2CH_2COO$-) (peak a) is proportional to the added SDMF content. This result confirms that the ionic group can be introduced efficiently to the PBS backbone. As seen in Fig. 1, as the concentration of PBSi and the applied voltage were increased, the morphology was gradually developed from button-like droplets to beaded fibers. At 15 wt%, the concentration of PBSi was fixed since the morphology exhibited the entanglement concentration (Ce) to be formed the fibrous web.



(a) 5wt%, 15kV (b) 8wt%, 15kV (c) 10wt%, 15kV (d) 15wt%, 15kV (d) 15wt%, 20kV

Fig. 1. SEM images of the electrospun PBSi.

4. Conclusion

It was first fabricated the nano-sized web of poly (butylene succinate) ionomer (PBSi) by means of electrospinning. It was found that the morphology was changed from button-like droplets to beaded fibers at 15 wt% and 15kV, the concentration of PBSi solution and the applied voltage, respectively. The electrospun poly (butylene succinate) ionomer (PBSi) nano-web would have some potential in multifarious application fields such as filters, catalyses, protecting clothes, implants, and tissue engineering, etc.

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