Nano-web structures constructed with a cellulose acetate/lithium chloride/polyethylene oxide hybrid: Modeling, fabrication and characterization

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ABSTRACT

Electrospun nano-web structures (ENWSs) were successfully fabricated from ionized binary solution of cellulose acetate/polyethylene oxide (CA/PEO of 0.5–1.5). Final concentration of polymers was 12% (w/v) in the solution, and lithium chloride was used as ionizing agent. Response surface methodology (RSM) was applied to the optimize fabrication of ENWSs. Results of multiple linear regression analysis revealed that the solution properties and ENWSs morphology were strongly influenced by CA/PEO. An increase in PEO amount increased the viscosity which is a function of molecular weight, and as a result raised the entanglement of polymeric solution but decreased the surface tension that all support nanofibers fabrication. The size of nanofibers decreased with reducing PEO and LiCl concentration. Increasing the content of LiCl promoted the electrical conductivity (EC) value; however, junction zones were formed. The overall optimum region was found to be at combined level of 1.5% CA/PEO and 0.49% (w/v) LiCl.

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1. Introduction

Over the past decade, some novel and important applications for using the electrospun nano-web structures (ENWSs) were found in various fields such as delivering vehicles for nutrients and nutraceuticals or other bioactive compounds, coating as fibrous film with highly porous nature and much greater surface area in comparison with conventional solution-cast films, protective nature for encapsulated active compound, carrier for antimicrobial compound, filtration media, biosensor application, and immobilization of enzyme on nanofibrous membrane (Kayaci & Uyar, 2012; Kriegel, Arrechi, Kit, McClements, & Weiss, 2008; Sozer & Kokini, 2009). ENWSs in comparison with other nano-scaled solid materials showed the enhanced interactions with their surrounding medium and thus can be considered as perfect substantial for exhibiting intrinsic features including open porous construction and continuous nano-web formation, which enable the easy accessibility of reactive compounds and prevent low mass diffusion in the different biosystems. Furthermore, ENWSs can be easily recovered and re-used for continuous operations (Kenawy, Abdel-Haya, El-Newehya, & Wnek, 2009). Several methods have been developed to fabricate highly porous biodegradable scaffold including, solvent casting, emulsion freeze–drying, gas forming, particle leaching and three dimensional (3D) printing (Yao, Li, & Song, 2007), but the electrospinning technique has been recognized as an efficient and cost-effective method to fabricate nano-scale fibrous structures (Kriegel et al., 2008; Li, Lim, & Kakuda, 2009; Sozer and Kokini, 2009; Wongsasulak, Patapeejumruswong, Weiss, Supaphol, & Yoovidhya, 2010; Yao et al., 2007). In this process, a powerful electric field is used to form and deposite non-woven nano-web from polymer solution, when a high electric field is applied on polymer solution leading to the droplet deformation (Yao et al., 2007; Wongsasulak et al., 2010). The composition of the solution (e.g.,


