タイトル: Morphology, Structure and Properties of Electrospun Polymer and Composite Nanofibers

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ABSTRACT

In this study, structure evolvement of polymer and composite nanofibers in electrospinning process was studied. In the case of pure polymer nanofibers, electrospinning parameters, spinneret and solution properties including viscosity and viscoelasticity, and stretching force generated onto polymer jets during the electrospinning were varied to investigate the spinneret effect. The solution properties were changed by changing molecular weight of polymer used, while the stretching force was varied by increasing conductivity of the solution with an additive and changing take-up velocity. In the case of composite nanofibers, nanoparticles effect on structure of nanofibers were investigated in terms of nanoparticles content and chemical structure. In addition, the processing-structure-property relationship of porous nanofibers was also investigated to obtain the fundamental understanding of electrospun polymer nanofibers.

With decreasing viscosity of solutions, and increase of stretching force generated by improved conductivity of solution and high take-up velocity, crystalline and molecular orientation within polyvinylidene fluoride (PVDF) fine nanofibers increased. Polylactic acid (PLA) nanofibers with highly porous morphology were fabricated with high molecular weight polymer, and could be manipulated by take-up velocity and spinneret types. It was found that surface pores did not lead to significant drop of the tensile properties of single porous nanofibers, and tensile properties can be maintained or improved by controlling surface morphology. The enhanced mechanical properties of porous nanofibers could be attributed to surface roughness, densely packed structure, and improved molecular orientation within

nanofibers. Polyhedral oligomeric silsesquioxane (POSS) / poly(ε-caprolactone) (PCL) composite nanofibers exhibited high molecular and crystalline orientation with the incorporation of POSS nanoparticles as the external stretching force and the presence of nanoparticles worked synergistically. The influence of POSS nanoparticles on internal structure of composite nanofibers could also be tailored by chemical structure of POSS and POSS content as a result of POSS-polymer interaction.

This thesis contributes to better understanding on the mechanism behind the structure evolvement of nanofibers and composite nanofibers during electrospinning, and to identify determining parameters that can be used to tailor their mechanical performance through morphology and structure control.