CHAPTER I
INTRODUCTION

Many different techniques have been developed to produce nanostructured materials. The electrospinning process has attracted a great deal of attention to produce non-woven membranes of nanofibers. This process can produce polymer fibers in the nanometer diameter range and can be utilized to assemble fibrous polymer mats composed of fiber diameter lower than 100 nm. The small diameter provides a high surface area to volume ratio, and a high length to diameter ratio. These characteristics arc well suitable in variety of applications, such as protective shields in special fabrics, filter media for submicron particles in separation industry, composite reinforcement, especially in biomedical applications including anti-adhesion membranes, wound dressing scaffold, drug delivery, artificial blood vessels and organs.

The electrospinning process has been realized by applying a high voltage to a capillary filled with the polymer fluid. At the end of the capillary, polymer fluid is held by its surface tension. As the intensity of the electric field is increased, the hemispherical surface of fluid at the tip of capillary elongates to form a conical shape (Taylor cone). When the repulsive electrostatic force overcomes the surface tension, charge jet of fluid will be ejected from the tip. The jet breaks up into droplets as a result of surface tension in the case of low viscosity liquids. For high viscosity liquids the jet does not break up, but travels as a jet to the grounded target. The first case is known as electrospraying and is used in many industries to obtain aerosols composed of sub-micron drops with narrow distributions. When applied to polymer solutions and melts, the second case is known as electrospinning and it generates polymer fibers that are sub-micron in diameter. The resulting fibers after solvent evaporatation are collected on the grounded plate, which can be covered with a fabric or may be the rotating cylinder covered with a grounded aluminium sheet.

The parameters and processing variables affecting the electrospinning process are divided into two types. System parameters such as molecular weight of polymer, viscosity of polymer solution, conductivity and surface tension. Process parameters such as electric potential, flow rate and concentration, distance between the capillary and the collector, ambient parameters and finally motion of target screen. For instance, the polymer solution must have a concentration high enough to cause polymer entanglement but not so high that the viscosity prevents polymer motion induced by the electric field. In addition, if the viscosity high enough, the jet will not collapse into droplets before the solvent has evaporated. The morphology of nanofibers can be changed by shifting of distance between the syringe needle and the substrate. Increasing the distance or decreasing the electrical field can decrease the bead density. Moreover the applied electric field can influence the morphology and create a variety of new shapes on the surface. For example, AC current may make a twisted or helical nanofibers.

Typically, electrospinning is applicable to a wide range of polymer i.e. polyolefin, polyamide, polyester, aramid, acrylic as well as biopolymers like proteins, DNA, polypeptides. Poly(ε-caprolactone) and poly(ε-caprolactam) are biodegradable and biocompartible polymers that have been widely used in biomedical application. Polystyrene is the commercial plastic used mainly for packaging. Nevertheless, there are many desirable properties as it was used popularly, polystyrene is not capable of self-decomposition. The disposal problem of plastic could be solved by the use of additives or by the development of new or modified structures decomposing by various mechanisms. Graft copolymer is a specialized structure that is created in order to attain the properties of each polymer component in a copolymer. Therefore, grafting polystyrene with biodegradable polymer is an appropriated method to produce a new polymer that has both the properties of polystyrene and the biodegradable polymers.

Among the efforts to speed up the biodegradation rate of polystyrene grafted with biodegradable polymer, increasing their surface area by processing them into ultrafine fibers is an effective way. In this study, polystyrene-graft-poly(ε-caprolactone)and polystyrene-graft-poly(ε-caprolactam) were synthesized and processed by electrospinning to obtain nanofibers. Variation of processing conditions, and their effects on the structure and morphology of resulting fibers will be studied.