CHAPTER I
INTRODUCTION

Carbon fibers are the primary reinforcement used to increase the stiffness and strength of lightweight advanced composites commonly used in aerospace, recreation, and industrial applications. The term carbon fiber generally refers to a variety of filamentary products composed of more than 90 % carbon, 5-10 μm in filament diameter, produces via pyrolysis of polyacrylonitrile (PAN), pitch, and rayon. For conversion of carbon fiber precursors to carbon fibers, three steps, stabilization, carbonization, and graphitization were required.

Because carbon fibers have extremely high specific strength and modulus comparing to other engineering materials, they are predominately used in weight critical applications. The properties of carbon fiber are excellent when it has high molecular orientation, small fiber diameter and small amount of surface defects. It is generally accepted that a major limitation to the tensile strength of polyacrylonitrile-based carbon fibers is the presence of surface defect and large fiber diameter. Recently, there has been a trend towards thinning precursor fibers to obtain carbon fibers with smaller diameter (4.5-5.0 μm compared to the 7-8 μm diameter usually obtained). Therefore an electrospinning process will be performed to produce carbon fibers with intention of attenuating fiber diameter to promote more uniform heat treatment, increasing molecular orientation to promote modulus and avoiding a skin-core morphology, which occurs in other spinning processes.

Electrospinning is a unique process that uses an electrical field to create an electrically charged jet of polymer solution or melt, which dries or solidifies to leave a polymer fiber. The properties of fiber obtained from this process depend on two types of parameter, the first is system parameters including molecular weight, molecular weight distribution, architecture of the polymer e.g. branched or linear chain and solution properties (viscosity, conductivity and surface tension). The second one is processing parameters including electrical field strength, flow rate, solution concentration, distance between the capillary and the collector, and ambient parameter (temperature, humidity and air velocity in the chamber).

The advantages of electrospinning process are simple equipment, requiring a short time, cost effective process and producing a very high orientation fiber with very small pore sizes. Thus, the carbon nanofibers will not only useful in filters, but also be useful as a support for catalysts in high temperature reactions, in composites to improve mechanical properties, or for thermal management in semiconductor devices.

Therefore, this work focused on the effects of six processing parameters on the fiber morphology i.e. the fiber diameter, the density of bead, molecular orientation. The processing parameters include solution concentration, collection distance, electrical strength, take-up speed, electrode polarity and nozzle radius. Finally, the thermal behavior of electrospun fibers was compared with the conventional PAN fiber by using differential scanning calorimetry (DSC). A commercial grade PAN was chosen for this study because it has been found that PAN is the most suitable precursor for making high-performance carbon fiber. Moreover, it is cheap, readily available and easy to find.