CHAPTER I

INTRODUCTION

Synthesis of carbon fibers have a received a considerable attention in recent years because of their enormous potential in a wide range applications wide range applications, from sports equipment to the aerospace industry [1]. Carbon fibers have very large surface area to volume ratio, flexibility in surface functionalities, superior mechanical performance are receiving increasing attention in characteristics that make the polymer nanofibers have many importance applications such as nanocomposites, rechargeable batteries, advance catalyst support, super capacitors, drug delivery and filtration. Fiber properties such as tensile strength, modulus (modulus between 100-450Gpa), porosity, and surface functionality depends on the type of precursor, the processing conditions, etc [2].

Electrospinning technique is a relatively simple and versatile method for fabricating nanofibers. In typical electrospinning process, a droplet of solution held by its surface tension at the end of a capillary tube is subjected to an electric field. Charge is induced on the liquid surface by electric field. As the intensity of the electric field is increased, the hemisphereical surface of the solution at the tip of the capillary tube elongates to form a conical shape know as the Taylor cone. When the electric field reaches a critical value at which the repulsive electric force overcomes the surface tension force, a charged jet of the solution is ejected from the tip of the Taylor cone. Since this jet is charged, its trajectory can be controlled by the electric field. As the jet travels in air, the solvent evaporates, leaving a charged fiber behind which lays itself randomly on a collecting metal screen. Thus, continuous fibers are laid to from a non-woven fabric [3]. In the continuous-feeding mode, the number of fibers can be formed within short period of time as short as a few seconds. Those fibers are often collected on the surface of a conductor to form non-woven mats that have high surface areas and relatively small pore sizes. For the past several decades, more than 20 different types of organic polymers have been successfully as ultrathin fibers using the electrospinning technique, with typical examples including various engineering plastics, biopolymer, and electronically conductive polymer [3].

In this work, the sol-gel method is combined with electrospinning technique to produce carbon fiber and spherical carbon particles. Resorcinol/formaldehyde (RF) gel was incorporated to the precursors to create porosity of the obtained carbon fibers and spherical carbon particles. RF gel can be prepared by the sol-gel polycondensation of resorcinol (R) and

formaldehyde (F) with sodium carbonate (C) as basic catalyst [4], [5]. Resorcinol/formaldehyde gel is a special type of highly cross-linked aromatic polymers with high pore volume and large specific surface area. Due to the unique function of the RF-derived carbon cryogels, which is relating to their excellent pore characteristics, we aimed to employ RF-gel to control pore size of carbon fibers and spherical carbon particles. The carbon gels derived from RF gel are used in variety of applications including electrode materials in rechargeable batteries, advanced catalyst supports, chromatographic packing, adsorbents for gas separation, etc [6-8]. There are several reports to form carbon micro-spheres by disperst in RF sol in organic solvent by pyrolysis in inert atmosphere. To the best of our knowledge, it is the first report on synthesis of carbon fibers by electrospinning method.

Aim of this study is to understand the influence of various effects of various processing parameters, such as applied electrical field strength, working distance, applied voltage, as well as the preparation condition for RF gel, such as composition and aging time, on the size, size distribution, morphology, surface area and pore volume of carbon fibers and carbon nanospheres prepared by electrospinning followed by pyrolysis. Addition of aluminium precursor, i.e., aluminium acetylacetonate into the RF-gel by electrospinning method was investigated. This research intends to investigate the production of carbon fibers and carbon nano-spheres to produce mesoporous structure while RF gel was in the gelation process and investigated in more detail of their physical and chemical properties.

Objectives of the research:

1. To synthesize mesoporous structure of carbon fibers and carbon nanospheres from RF gel by electrospinning technique.
2. To investigate size, size distribution, morphology, as well as physical and chemical properties of fibers and nanospheres of RF gel by changing the processing parameters and preparation condition for RF gel and to investigate the formation and morphology of RF fibers and RF nanospheres aged in different relative humidity.
3. To investigate rheological behavior of the spinning solution.
4. To investigate product obtained from doping aluminium into RF gel and fabricated by electrospinning technique.

The present study is arranged as follows:

Chapter I is the introduction of this work

Chapter II described the basic theory about carbon fibers, sol-gel process and resorcinol/formaldehyde (RF) gel, electrospinning process. Furthermore, literature survey of the previous works related to this research is also presented in this chapter.

Chapter III shows materials, the experimental equipments, the preparation of RF fiber and RF particles by the elctrospinning process and characterization equipment.

Chapter IV describes the results and discussion of the research.

In the last chapter, the overall conclusions of this research and future work are given.