CHAPTER I
INTRODUCTION

In the last decade, a new kind of polymers has emerged which can respond to external electrical stimulation by displaying a significant change in shape or size. These materials, known as electroactive polymers (EAPs), are now on the verge of many exciting applications such as actuation devices, artificial muscles, catheter steering elements, miniature manipulators, dust-wipers, miniature robotic arms and grippers (Cohen, 2001).

The electro-viscoelastic elastomer is one type of electroactive polymers that use the mobility of ions as the driver in activation mechanism. Typically, it is a composite consisting of polarizable particles embedded in an insulating matrix, such as a gel or an elastomer. This material behaves like a fluid before crosslinking. An electric field is applied during curing to orient and to fix the position of the particles in the matrix. This material is changed into a solid state but still has shear moduli that may vary with applied electric field (Martin et al., 1999). This system has several advantages as compared to other types of electroactive polymers such as it has neither current leakage nor particle sedimentation, and it also provides the right shape and size for various applications. However, the application of electric field for orientation and the curing of the matrix for fixing particle positions seem to be quite complicated. So, the development of an electroactive polymer that uses the same basic activation mechanism with electro-viscoelastic elastomer but employs an easier fabrication method seems to be more promising.

Poly(vinyl alcohol) (PVA), a water-soluble polyhydroxy synthetic polymer, is a hydrophilic, semi-crystalline polymer that has received much interest in recent days because of its good chemical and thermal stability, good physical properties, and complete biodegradability (Martien, 1986; DeMerlis *et al.*, 2003). Moreover, PVA is one member of hydrogel or a three-dimensional network structure of a hydrophilic polymer capable of containing large amounts of water. PVA can be called a physical hydrogel because its three-dimensional network structures are not covalent bond, but they come from the self formation of hydrogen bonds between

polymer chains. From the above reasons, PVA may possibly be used as the matrix of electroactive polymer instead of an elastomer.

Typically, conductive polymers have been frequently chosen to be used as the polarized particles in electroactive polymers because they can be induced to provide a greater polarization force than any other types of materials. However, conductive polymers are the expensive materials. An alternative material that may be used instead of conductive polymers is carbon black, an amorphous carbon in the form of near-spherical colloidal particles; since it has quite low cost, polasizable property, and very small size of particles.

When the diameters of polymeric materials are shrunk to sub-micrometers or nanometers, there appear several amazing characteristics such as very large surface area to volume ratio, flexibility in surface functionalities, and superior mechanical performance compared with any other known forms of materials because of the presence of tiny defects. One of processing techniques that can be used to make ultrafine fibers which has received much attention in recent years is the electrostatic spinning or electrospinning; it is the process that utilizes high electrostatic potentials in fabricating ultrafine fibers (Haung et al., 2003). Various materials have been successfully electrospun into ultrafine fibers, e.g. biopolymers, engineering plastics, conductive polymers, block copolymers, polymer blends, ceramics, and composite materials, mostly from polymer solutions or melts, including PVA. There are many researchers reported that PVA was successfully fabricated into ultrafine fibers by electrospinning and was used in several applications, but none of them was reported in its applications along with electric field.

Here we are interested in employing the electrospinning method to fabricate carbon black-PVA composites nanofibers, and to develop them as electroactive polymers by study their mechanical and electroactive properties.

Therefore, in this work, we investigated the electrospinning of the carbon black-filled electroactive electrospun polymeric nanofibers through mixing carbon black with PVA. An attempt was made to understand the effects of solution properties (concentration and viscosity), experiment set ups (applied potential and collection distance), and carbon black composition on the elctrospinnability and the

morphological appearance of the as-spun PVA fibers. The effects of carbon black composition on the mechanical and electrorheological properties of electrospun fibers were also investigated.