CHAPTER I
INTRODUCTION

The exchange of electrical energy for mechanical energy has been of scientific and technological interests for many decades. Electromechanical energy conversion has been applied in various applications such as muscle/insect-like actuators, robotic, etc. (Krause *et al.*, 2001). Electroactive polymers (EAPs) offer promising and novel characters such as light-weight, high energy density and high flexibility; they are suitable material candidates for muscle-like actuators. On the other hand, dielectric elastomers are a type of electric-filed-activated electroactive polymer that is capable of undergoing large strains, possessing fast response, and high efficiency (Kornbluh *et al.*, 2002).

Polyisoprene or natural rubber is one type of dielectric materials which has many advantageous characters; inexpensive due to its natural source, flexible polymer, low swelling in water, high tensile strength, good resilience, high hot tensile, and well behaved hysteretic. Polyisoprene is produced and used in many products; for example, tires, rubber bands, cut thread, baby bottle nipples, footwear, sponge, and sporting goods. In addition, it is an elastomeric polymer because it can recover its shape after being stretched or deformed, and it is also an insulating polymer. A desirable property is that it can allow large actuation strains by subjecting the material to an electrostatic field.

Recently, incorporation of a conductive polymer into a dielectric elastomer has been of keen interest. Conductive polymers can offer a variety of advantages to the host elastomer: good conductivity, better thermal stability, and mechanical properties (Küçükyavuz *et al.*, 2002). Examples are polyanilene-polyisoprene blend for biosensor applications (Shen *et al.*, 2001), polyanilene-EPDM blend (Faez *et al.*, 2002), and TiO_2 embedded in PDMS gels for actuator applications (Zrínyi *et al.*, 2000).

Since the 1970s, the discovery of conductive polymers has been unique in its accomplishment as a possible substitute for metallic conductors and semiconductors due to several advantages: lightweight, inexpensive, and potentially possible nature. Conductive polymers are a new class of organic materials; these materials generally are comprised simply of C, H and simple heteroatoms such as N and S, and π-conjugation electrons (Chandrasekhar, 1999). The intrinsic electronic conduction in these polymers is achieved by the movement of charge carriers. These carriers can move efficiently along a conjugated polymer chain (interchain transport) (Davidson and Ponsonby, 1999) relative to the non-conjugated polymers. There are several routes for synthesizing polymers that can be converted into conductive polymers, the incorporation of extended π-electron conjugation: chemical polymerization, electrochemical polymerization, plasma polymerization, and etc. There are several polyaromatic based conducting polymers: polythiophene, polypyrrole, polyaniline, poly(p-phenylene) and poly(phenylene vinylene) (Küçükyavuz *et al.*, 2002). These conductive polymers have many potential applications such as plastic batteries, sensors, conductive surface, magnetic recording, actuators and etc.

One of conductive polymers is polythiophene. Polythiophene is a heteroaromatic conductive polymer. It has many advantages: high conductivity; high stabilities in aqueous media and air; the polymerization and doping methods are simple which gives a high yield; it can exhibit electrically triggered molecular conformational transition (Kumar and Sharma, 1998; Mu and Park, 1995; Anquetil *et al.*, 2002). There have been several applications for polythiophene; e.g., iodine doped polythiophene battery, electro-optical display devices, humidity sensors, radiation detectors, gas sensor (Kumar and Sharma, 1998; Chandrasekhar, 1999).

In our work, we are interested in development polythiophene/polyisoprene elastomer blends as a substitute for artificial muscles. The mechanical properties, viscoelastic properties and electrical properties will be investigated in terms of degree of polyisoprene crosslinking, electric field strength, and polythiophene concentration in order to understand its behavior under electric field.