CHAPTER I
INTRODUCTION

For years scientists have attempted to mimic natural muscles. Investigators have worked on the control of different energetic sources and the transformation between different types of energy. An actuator is a device controlled by an electrical signal it receives such that it can respond by an extention or a retraction of its sizes. There are many kinds of actuators such as Pneumatic Actuators, Shape Memory Alloys (SMA), Electroactive Ceramics, and Electroactive Polymers (EAPs), the most recent approach to artificial muscle (Madden *et al.*, 2004).

An attractive characteristic of Electroactive Polymers (EAPs) is their ability to emulate the operation of biological muscle with high fracture toughness, large actuation strains, and inherent vibration damping. One of the most outstanding Electroactive Polymers (EAPs) is Dielectric elastomers being capable of producing large strains, fast response, and high efficiency (Bar-Cohen, 2004). These actuators work at a high voltage, so the introduction of a conductive polymer into an elastomer is used to overcome that problem (Kyokane *et al.*, 2005).

Acrylonitrile-butadiene rubber (NBR) is one type of elastomers which has excellent resistance to petroleum products, over a wide temperature range. With higher acrylonitrile content, the molecules become less hydrophilic and more polar, so NBR has quite good miscibility with conductive polymers (Yong *et al.*, 2006). Therefore, conductive materials based on nitrile rubber have been the subject of research and development activity for a number of years (Sau *et al.*, 1999, Vallim *et al.*, 2000, Cho *et al.*, 2006, and Soares *et al.*, 2006).

Polythiophene is an excellent class of electronic conductive polymer which has many advantages: high conductivity; high stabilities in aqueous media and air; the polymerization and doping methods are simple which give high yield; it can exhibit electrically triggered molecular conformational transition (Kumar and Sharma, 1998; Mu and Park, 1995). This material is viewed as potentially useful components in field-effect transistors, optical and electronic sensors, light-emitting devices, nonlinear optical materials, etc. Substitution at the 3- and/or 4-position of the thiophene ring not only confers processability to poly(thiophene)s but can also be used to modify their electrooptical properties through electronic and steric interactions (Li *et al.,* 2001).

The presence of fillers and other electrically conductive additives in elastomers were observed to alter electrical and mechanical properties, and morphology (Sau *et al*., 1998, Eid and El-Nashar, 2006, and Yong *et al*., 2006). The effect of particles embedded in polymer matrices on dynamic viscoelasticity, was investigated by using doped poly(3-hexylthiophene), (P3HT), in a silicone elastomer under the influence of electric fields (Shiga *et al*., 1993).

In our work, we are interested in elastomeric actuator materials; Acrylonitirle-butadiene rubber containing a conductive polymer; Poly(3-thiopheneacetic acid) to be used as artificial muscles. The effects of the acrylonitrile content in acrylonitirile-butadiene rubber, and particle concentration on electrorheological properties and dielectric properties of pure and the blends were studied.