CHAPTER I
INTRODUCTION

Polymer artificial muscle technology is being developed for large macroscopic deformations by repetitive molecular motions that produce high strains and high stress by electrostatic forces, ion insertion, and molecular conformational changes. Polymer artificial muscles have been divided into two major groups (Mirfakhrai *et al.*, 2007). The first group is electronic electroactive polymers (EAPs) in which the dimensional changes occur in response to an electric field, for examples: dielectric elastomer, piezoelectric polymer, liquid crystal elastomer (Mirfakhrai *et al.*, 2007). The second group is ionic electroactive polymers (DEAs) (Mirfakhrai *et al.*, 2007) in which the movement of ions is required to make an actuation possible, for examples: conductive polymers, polymer gels, ionic polymer-metal composites, and carbon nanotubes. The applications of artificial muscles are for animals, human, and the creation of human-like robots. It is also possible to consider artificial muscles for medical purposes. Electroactive conductive polymers can be used to enhance the electrical and mechanical responses where biopolymers are used as the matrix phase.

Alginates are natural anionic biopolymers extracted from brown seaweeds. They are unbranched polysaccharide consisting of 1,4-linked b-D- mannuronic acid and a-L-guluronic acid units (Kuen *et al.*, 2012), which are covalently linked together in different numbers and sequence distributions along the polymer chain, depending on the alginate source. Alginates have been extensively investigated and used for many biomedical applications, due to its biocompatibility, low toxicity, relatively low cost, and can be prepared through gelation method at room temperature (Kuen *et al.*, 2012). The mechanical properties of alginate can be controlled by changing certain parameters, such as the polymer source, molecular weight, concentration and chemical modifications, and the type and density of the crosslinking.

Alginates are typically used in the form of a hydrogel in biomedicine, including wound healing, drug delivery, and tissue engineering applications (Kuen *et al.*, 2012). Hydrogels are three dimensionally crosslinking networks composed of

hydrophilic polymers with high water content. Hydrogels are often biocompatible, as they are structurally similar to the macromolecular based components in the body, and can often be delivered into the body via minimally invasive administration. Chemical or physical crosslinking of hydrophilic polymers are typical approaches to form hydrogels, and their physicochemical properties are highly dependent on the crosslinking type and crosslinking density, in addition to the molecular weight and chemical composition of the polymers.

Polycarbazole is one of the conductive polymers that contain two six-membered benzene ring fused on side of a five-membered nitrogen containing ring. It is synthesized through either electrochemical or chemical method. (Gupta and Prakash *et al.,* 2010). Mostly, it can be used in the applications of light-emitting diodes, electrochromic displays, organic transistors, and rechargeable batteries (Harun *et al.*, 2007; Gupta *et al.*, 2010; Raj *et al.*, 2010) due to it conductivity. Also, it is water-insoluble and stable in the ambient environment that provides more advantage for mixing with hydrogel relative to other conductive polymers.

In this work, the objective is in fabricating an electroactive material from alginate in form of hydrogel as the matrix phase filled with polycarbazole. A small amount of polycarbazole partilces was added as a dispersed phase to improve the electrical and electromechanical properties of the alginate hydrogel. It is the main interest to study the alginate hydrogels and polycarbazole/alginate hydrogel composites for an actuator application. The electromechanical properties and actuator performances were investigated and examined under the effects of molecular weight of alginate, crossliking types, polycarbazole concentrations, and electric field strengths.