CHAPTER I
INTRODUCTION

Hydrogel technologies have stimulated development in many biomedical applications such as controlled drug delivery due to their non-toxicity, biocompatibility, and similarity to biological tissues (Langer *et al.*, 2003 and Peppas *et al.*, 2004). Hydrogels are water-swollen polymeric materials possessing three-dimensional network structures. The network provides physical integrity and it is insoluble due to the presence of chemical or physical crosslinks (Peppas *et al.*, 2004 and Kim *et al.*, 2003).

Polysaccharides are one choice to be used as a hydrogel because they are quite similar to living tissues, useful for a wide variety of biomedical applications. Moreover, they are usually non-toxic, biocompatible, and show a number of peculiar physico-chemical properties. Carrageenan, a polysaccharide, has the ability to form thermoreversible hydrogels and is extensively used as a gelling agent in food and pharmaceutical industries. Because of its gelling and viscosity building properties and proven safety, ithas been utilized in sustained-release materials (Gupta *et al.*, 2001). Carrageenan comprises a family of linear water-soluble sulfated polysaccharides extracted from red seaweeds. The well-known carrageenan is kappa-carrageenan (κ-carrageenan) that can form a hydrogel easily. It is mostly alternating polymer of D-galactose-4-sulfate and 3,6-anhydro-D-galactose (Nijenhuis, 1997 and Zhai *et* al., 1998). The gelation of κ-carrageenan involves a coli to helix conformational transition followed by helix aggregation. The process is thermoreversible and can be induced by cooling and promoted by multivalent cations. The thermo-sensitive nature of κ-carrageenan hydrogels makes this biopolymer an interesting choice in drug delivery applications. In addition, the structure of κ-carrageenan includes a variety of chemical functional groups, providing the possibility for future derivatization and bioconjugation (Daniel-da-Silva *et al.*, 2011).

However, the limitations of controlled release by hydrogel are the slow response which limits their ability to deliver the stimuli efficiently throughout the gel (Lira *et al.*, 2005). The use of an electric field as an external stimulus is a method

that has been successfully employed to enhance the amount of drug release and the precise controls (Chien *et al.*, 1990). Because the electronic conductivity of a hydrogel is generally low, the current from an electric stimuli is not readily transmitted throughout the structure.

Recently, a conductive polymer combined with a hydrogel has attracted attentions as an electroactive hydrogel which is capable of chemical or physical transformations in response to electrical potential. Therefore, the conductive polymers and hydrogel blends have been extensively investigated for controlled drug release (Tao *et al.*, 2005).

Polythiophene (PTh) is an important class of conjugated polymers due to its high thermal stability, processibility, solubility, and excellent electrical conductivity when in a doped state (Stevenson *et al.*, 2010). PTh results from the polymerization of thiophenes which can become conducting when electrons are added or removed from the conjugated π-orbitals via doping (Lee *et al., 2008*). PTh is synthesized by the electrochemical and chemical polymerization methods. But the chemical oxidative polymerization is more applicable than electrochemical method because of controllable sizes and a higher yield (Gnanakan *et al.*, 2009).

In this work, polythiophene/carrageenan blend films will be prepared. The electrical conductivity of polythiophene will be studied as a function of doping level. The release mechanism will be investigated in terms of crosslinking agent type and ratio and electric field strength. Furthermore, the electrically stimulated controlled release behavior of the acetylsalicylic acid as model drug from the blend film will be investigated.