CHAPTER I

INTRODUCTION

1.1 Statement of problem

Polymers are used in a large number of applications because of their several advantages. For applications requiring photonic and conductive properties, the choice of interest is a conducting polymer. The idea of using polymers for their electrical conducting properties actually emerged in 1977 with the findings of Shirakawa *et al* [1, 2] that iodine doped *trans*-polyacetylene, $(CH)_x$, exhibits of conductivity of conducting of 10^3 S/cm. This opened an entire new field for the discovery and development of conducting polymers, and the Nobel Prize in Chemistry was award to Alan J. Heeger, Alan G. MacDiarmid, and Hideki Shirakawa in 2000 [3]. Since then, an active interest in synthesizing other organic polymers possessing this property has been initiated. As a result, other conducting polymers having π-electron conjugated structures (conjugated polymers), such as polyaniline (PAni), polypyrrole (PPy), polythiophene (PT), poly(p-phenylene), and polycarbazole have been synthesized [4-9]. The conductivity of these polymers can be tuned from insulating regime to conducting regime by chemical modification and nature of doping. Among conducting polymers, polypyrrole is one of the extensively studied electronic materials. Though this material received considerable interest, processing it into a thin film is still a challenging task because of its intractability, insolubility, and infusibility in most of the common organic solvents and various technological applications. PPy found applications as transparent electrode in polymer light-emitting diodes, photoelectrochemical cells, flexible plastic transistors and electrodes, electroluminescent polymer displays, batteries, electromagnetic shielding, conducting textiles and fabrics, and gas sensors [10-12]. These polymers have been generally synthesized by two methods, electrochemical and chemical polymerization [13]. However, these methods are not suitable for producing the polymer films [6, 14]. A precise current density control is required to produce films in the electrochemical method and the obtained films are rather fragile restricted [15, 16]. As the chemical polymerization produces insoluble powders, it is hard to make film samples [17, 18]. Plasma polymerization technique is well known to be a useful process to produce polymer films, which are formed by reactions in gas phase without introducing any chemical oxidant compound on the different types of surface [19].

So far, polymer synthesized by plasma technique is interesting due to the environmentally friendly nature of the technique [6, 14, 20], besides this, polymer films are adherent and a high degree of cross-linking. Then, this film is dense and pinhole free. To date, there are several researches have been reported on the synthesis of polypyrrole films by plasma polymerization [14, 19, 21-36]. For instance, polypyrrole synthesized by radio frequency (RF) plasma polymerization and doped with 4-ethylbenzenesulfonic acid or iodine for study conductivity of polypyrrole films [19, 22-27]. Nevertheless, none has been mentioned on the synthesis of polypyrrole films by AC plasma polymerization.

In the present study, we designed and assembled AC plasma reactor to synthesize polypyrrole films as also varies reaction time, and voltage. The polypyrrole film growth was characterized by attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR), solid-state UV-visible spectroscopy, scanning electron microscopy (SEM), and electrical conductivity measurement.

1.2 Objectives

The goal of this research is to design and assemble an AC plasma reactor for the synthesis of polypyrrole films by AC plasma polymerization. An *in situ* doping of plasma polymerized pyrrole with iodine will also be investigated to increase electrical conductivity of the films.

1.3 Research Plan and the Scope of Investigation

The investigation was carried out as follows.

1. Literature survey for related research work.
2. Design and construction of AC plasma instrument

3. Test of the AC plasma reactor and the entire assembly with Optical emission spectroscopy (OES) to determine electron temperature
4. Synthesis of polypyrrole by AC plasma polymerization: optimize processing parameter
    - Reaction time: 30, 60 and 90 minutes
    - Voltage: 800, 900, 1,000, 1,100, 1,300 and 1,500 volt
5. Synthesis of polypyrrole doping by *in situ* doping with iodine
    - Reaction time: 30, 60 and 90 minutes
    - Voltage: 800, 900, 1,000, 1,100, 1,300 and 1,500 volt
6. Synthesis of polypyrrole by chemical polymerization for comparison
7. To study the effect of doping with I_2 as a function of storage time.
8. Characterization of polypyrrole films: analyses with the following techniques will be carried out:
    - Attenuated total reflection Fourier transform infrared spectroscopy (ATR-FTIR) to characterized important functional groups in material
    - Solid-state UV-visible absorption (UV-Vis) to determine optical properties of the material obtained
    - Scanning electron microscopy (SEM) to investigate surface morphology of the fabricated material
    - Energy-dispersive x-ray spectroscopy (EDS): to determine elemental composition of the material
    - Electrical conductometric determination to measure electrical conductivity of the fabricated material
9. Data analysis