CHAPTER I
INTRODUCTION

Ammonia gas has been known to be hazardous to both humans and the environment. Due to its high toxicity, even low level concentrations (ppm), it can pose a serious threat. The industrial processes, including fertilizer manufacturing, chemical manufacturing, livestock farms as well as its use as a refrigerant involve the use of ammonia gas. Existing ammonia gas-sensing devices show low selectivity and sensitivity. A new approach is desirable to increase the sensor selectivity and sensitivity towards ammonia gas (Brantley, 2004).

One method for dealing with this problem is the use of conductive polymers in gas sensing applications. In comparison with most of the commercially available sensors, based usually on metal oxides which are operated at high temperatures, the sensors made of conducting polymers have many favorable characteristics. They have high sensitivities and moderately short response times; especially, these features are ensured at room temperature. Conducting polymers are easy to be synthesized through chemical or electrochemical processes, and their molecular chain structure can be modified conveniently by a copolymerization or structural derivations. Furthermore, conducting polymers have moderately good mechanical properties, which allow a facile fabrication of sensors (Bai *et al.,* 2007). Polythiophene has several advantages over other semiconducting polymer particles; it can be easily polymerized by an oxidative polymerization at relatively low temperature to giving a high yield, and it can be doped from an insulating state to a conducting state by using simple protonic acids (Puvanatvattana *et al.,* 2008). A polythiophene film can expected to show a highly sensitive response to ammonia and that the response can be easily recovered with N_2. Furthermore, with the proven reproducibility, it has a number of important applications as gas sensors, such as electronic noses (Ma *et al.,* 2006). Therefore this work is aimed to investigate Poly(3-thiopheneacetic acid)(P3TAA) as NH_3 gas sensor.

Zeolites are naturally and synthetically occurring aluminosilicate minerals with three-dimensional structure based on $[SiO_4]^{4-}$ and $[AlO_4]^{4-}$ polyhedral (Chuapradit *et al.,* 2005). The regularity in channel dimensions controls accessibility and makes zeolites much more selective in the adsorption of specific molecules as compared to amorphous carbon or silica gel, which have irregular pore systems. This is the reason for their widespread use as molecular sieves. The same characteristics explain the ever-increasing role that zeolites and related zeotypes have in heterogeneous catalysis (*e.g.* for the petrochemical industry, pollution control and fine chemistry). Moreover, their ability to encapsulate organised molecules, crystalline nano-phases and supramolecular entities inside their channels and pores makes zeolites promising materials in the field of low-dimensional physics, where the quantum effects due to the spatial confinement become observable. Semiconductor quantum wires and quantum dots can thus potentially be obtained by hosting semiconductor crystalline nano-phases inside the channels or cages, so obtaining interesting applications in the fields of optoelectronic, non linear optics, photochemistry, and chemical sensors (Lamberti *et al.,* 2001). Zeolites with encapsulated transition metal complexes are very convenient materials for investigating guest-host interactions and their influence on the physical and chemical properties of the encapsulated complexes. Zeolites provide well-defined rigid and stable frameworks with cavities of various sizes and shapes, so that the encapsulation of transition metal complexes in these cavities allows us to vary their environment in a controlled manner. The supercage of zeolite Y has a diameter of about 13 Å and openings of approximatively 7.4 Å (Vargas *et al.,* 2009). Due to the size-and-shape selectivity of zeolite crystals, zeolites of type Y are utilized to promote or to demote one species of gas interaction via the size selection and the cationic interaction (fig 1).

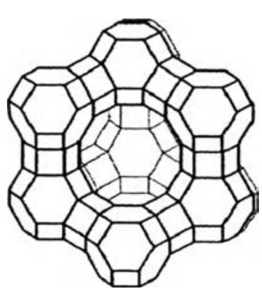

Figure 1.1 Zeolite Y structure, Faujasite [FAU] (Grey *et al.,* 1997).

The objectives of this work are to investigate the effects of zeolite contents and Si/Al mole ratios on the electrical conductivity response of P3TAA/Zeolite Y composites toward ammoniua gas. The scope of this research covers as follows: the synthesis a conductive polymer, polythiophene, and the fabrication with commercial zeolites of type Y forming composite sensing materials, and the use as a selective NH_3 gas sensor. The electrical conductivity sensitivity of P3TAA/zeolite Y composites when exposed to NH_3 gas are investigated.