# CHAPTER I
# INTRODUCTION

Presently, the industrial safety and environmental protection are of critical concern. Especially, many toxic and flammable gases are widely used in industry and power plants. In addition, we need a reliable control of the amounts of these gases which are involved in many industrial processes. Therefore, it is essential to develop reliable, stable, inexpensive, and compact gas sensors with high sensitivity and selectivity toward the target gases; such as, carbonmonoxide (CO), carbondioxide ($CO_2$) hydrogen ($H_2$) and ammonia ($NH_3$).

Ammonia produces a sharp smell, penetrating odor and it can quickly revive the faint of heart and light of head. At standard temperature and pressure, ammonia is a gas. But more than a sniff of this toxic, reactive, and corrosive gas can make one very ill indeed (George *et al.*, 2000). It can, in fact, be fatal. Nevertheless, it is also a chemical widely used in fertilizers, plastics, and explosives. Because of its low boiling point and its many uses, the risk of ammonia leak dangerous. From the safety issue, specific sensors are required to detect and monitor the ammonia leakage.

Generally, gas sensor devices are produced from metallic oxides such as $SnO_2$ (Srivastava *et al.*, 2006), ZnO (Wagh *et al.*, 2006), $WO_3$ (Stankova *et al.*, 2006), $TiO_3$ (Zhu *et al.*, 2000), $In_2O_3$ (Niu *et al.*, 2006), etc. However, there are some disadvantages with metallic oxides; they are required to operate at elevated temperature to ensure sensor sensitivity and selectivity. To improve gas sensor characteristic, electronic conductive polymers are potential candidates.

Conductive polymers contain conjugated system with $\pi$-electrons delocalized along the polymer backbone, thus they possess the electrical and magnetic properties of metal, while retaining the mechanical properties of polymers. The advantages of conductive polymers as gas sensor compared to inorganic materials are their diversity, their ease to synthesize, low cost, light weight, flexible molecular architectures, simple fabrication techniques (Prissnaroon *et al.*, 2000), and in particular their sensitivity at room temperature. Nevertheless, no commercial systems have been developed because of the remaining problems of poor reversibility and selectivity of these materials. Therefore, the improvement of sensor

selectivity becomes one of the principal factors that have to be achieved in order to recognize different specific chemicals.

Zeolites are the subject of intense interest as chemical sensors and as advanced materials due to their nanometric sized channel system providing a size and shape-selective matrix for absorbed molecule while maintaining a high surface-to-mass ratio (Dyer, 1988). Zeolite is not constructed from only silicate tetrahedral ($SiO_4$), but also aluminate tetrahedral ($AlO_4$); therefore, the presence of aluminium in the zeolite framework leads to the appearance of cations. The selective adsorption mechanisms of zeolite can be summed up into two main mechanisms (Vilaseca *et al.*, 2006). First, the nanometric size of pores can be utilized to process the molecular sieve property, molecules small enough to pass through are adsorbed while larger molecules are not. Second, the zeolite chemical composition, or the Si/Al ratio, is the main factor controlling the hydrophilic/ hydrophobic properties of materials. The introduction of specific cations, by using the cation exchange method, can alter gas adsorption properties.

In order to fabricate the sensor with good selectivity which can be operated at room temperature, A conductive polymer and a zeolite are mixed together to combine the advantages of these two materials. In this work, we propose the fabrication of poly(*p*-phenylene)/zeolite composites as ammonia gas sensor. ZSM-5 zeolite is used as an absorbent. The effects of ammonia concentration, zeolite content, and cation types including $H^+$, $Na^+$, $K^+$ and $NH_4^+$ on the electrical conductivity response towards ammonia are systematically investigated.