# CHAPTER I
# INTRODUCTION

Nowadays, energy and environmental problems are critical concern for human being and global issue. Fuel cells have received much attention as one of the green alternative power sources which convert the chemical reaction to electrical energy with water and heat as by- products. Polymer Electrolyte Membrane Fuel Cell (PEMFC) is accepted to be the most promising types of fuel cell for portable electrical devices and automotives due to its simplicity in compact size as well as high power density with fuel flexibility (Smitha *et al.*, 2005).

One of the key component of fuel cells is the membrane which conducting proton from anode to cathode. Conventional membranes are perfluorosulfonic polymers which are commercially available under the commercial name of Nafion®(Du Pont), Dow, Aciplex® and Flemion®. These membranes provide excellent chemical stability and high proton conductivity at low operating temperature, which is averagely below 80°C. However, the high operating temperature to overcome the Pt catalyst poisoning by a trace amount of CO impurity existed in hydrogen fuel is required. Moreover, an increase in proton conductivity can be expected at high operating temperature (Zhang *et al.*, 2006). Based on these requirements, development of proton exchange membrane for working at elevated temperature is another challenge for research.

For the past several years, proton exchange system on anhydrous membranes (water-free system) functioned via the resonance structure of heterocyclic molecule have been recognized as an alternative way to overcome the limitation found in water based system (Yamada *et al.*, 2003). Many approaches have focused on the development of new materials either ther incorporation of the heterocyclic molecule into the main chain (Carollo *et al.*, 2006 and Zhai *et al.*, 2007) or side chain (Bozkurt *et al.*, 2001, Persson *et al.*, 2006and Fu *et al.*, 2006) or even blending with polymer (Kreuer *et al.*, 2001, Bozkurt *et al.*, 2003 and Karadedeli *et al.*, 2005). Because the mechanism of proton exchange in anhydrous system is still unclarified, the development from fundamental viewpoint is indeed important.

Therefore, it is an ideal if we can design some model compound to represent the proton exchange pathway and evaluate the most effective and efficient condition. Based on the information obtained from the model compound, we can design the most favorable proton transfer pathway through heterocyclic system and achieve the high proton conductivity.

In water free system, benzimidazole is one of ideal heterocyclic molecules which nitrogen atom acts as the proton acceptors and proton donor by forming a regular hydrogen-bonded network to lead consequently proton transferring pathway (Munch *et al.*, 2001). Therefore, in our present work, we propose a series of model compounds, as shown in Figure 1.1, containing di-functional benzimidazoles to investigate the structure related to proton transfer mechanism.

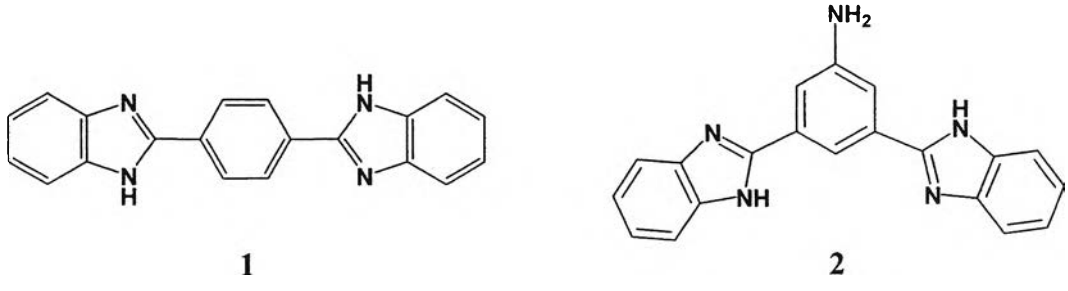


**Figure 1.1** Chemical structures of 1,4-di(1*H*-benzo[*d*]imidazol-2-yl)benzene, **1**, and 3,5-di(1*H*-benzo[*d*]imidazol-2-yl)benzenamine, **2**.