# CHAPTER I
INTRODUCTION

Fuel cells are receiving much attention as alternative sources to existing internal combustion engine because of their high efficiency and low emissions. It is believed that their potentials can be used to solve several major challenges; dependence on petroleum import, environmental problems, and greenhouse gas emissions. Fuel cell generates electricity by the chemical process, combining hydrogen and oxygen to form water and no more emissions. For transport and mobile applications, proton exchange membrane fuel cell (PEMFC) is the most promising type due to its low working temperature; however, its limitation is the CO tolerance (10-100 ppm). Many catalytic processes are being used to reduce CO concentration to part per million levels prior to entering the PEMFC.

The hydrogen storage and handling for mobile PEMFC are crucial problems. Many attempts in hydrogen storage (e.g. storage of high pressure tank or liquid hydrogen, storage in metal-hydride materials) are being discussed concerning safety and the size of storage tank for the sufficient amount. Therefore, the reforming of high density hydrogen content materials (e.g methane, methanol, ethanol, dimethyl ether, etc.) is preferable. One promising candidate for this application is methanol and the steam reforming of methanol reaction (SRM) shown in Equation 1.1

$$CH_3OH_{(g)} + H_2O_{(g)} \leftrightarrow CO_{2(g)} + 3H_{2(g)} \qquad \Delta H^0 = 49.5 \text{ kJ/mol} \qquad (1.1)$$
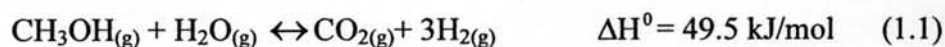
Although the SRM is an endothermic reaction, it yields about 75 vol% of hydrogen and conversion can be achieved at low temperatures. Moreover, methanol is low level hazardous of handling, inexpensive and easy for distribution. Hydrogen production via SRM gives the low CO concentration and the absence of harmful gases like NO_x or SO_x and particulate mater (PM). Methanol itself can be produced from various sources, such as natural gas, oil, coal, and renewable feedstocks (wood alcohol).

The conventional copper-based catalysts are being developed for methanol steam reforming; however, they have some drawbacks, such as deactivation when

contact with condensate steam, the exposure of the catalyst to high temperatures causes a loss of catalytic activity, and the unexceptional CO concentration for PEMFC in only reformer. Hence the purification process is needed. The non-copper catalysts have been studied to come over the weakness of copper-based catalyst, such as Pt/Al_2O_3 (Brown and Gulari, 2004), Pd/ZnO and Pd/CeO_2 (Ranganathan and Thompson, 2005), and Pd/Sm_2O_3 and Pd/CeO_2 (Gomez-Sainero et al., 2005).

The purpose of this research is to study the catalytic activity of supported gold catalysts for steam reforming of methanol under different operating conditions. In the case of Au/CeO_2, the catalysts are prepared by various techniques (Incipient wetness impregnation, Co-precipitation (CP) and Deposition-precipitation (DP)) and the Au/ZnO is prepared by Co-precipitation (CP) method. The catalysts are characterized by X-Ray Diffraction (XRD), Inductively Coupled Plasma (ICP) Spectroscopy, Temperature Programmed Reduction (TPR), Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). The study was covered the effect of preparation techniques on the size of gold metal, the effects of methanol/steam molar ratio(0, 1.33, and 2.00), reaction temperatures (200 – 450°C), catalyst support (Au/CeO_2 and Au/ZnO), and the size of gold catalyst on the activity and selectivity of gold catalyst for steam reforming of methanol at ambient pressure. Moreover, the stability of supported gold catalysts was also studied for about 15 hours.