CHAPTER I
INTRODUCTION

Because of the increasing of energy demands, crude oil price, and environmental concerns, many researchers keep going on searching for the new energy sources. Hydrogen, one of the most interesting alternative energies, is forecasted to become a major source of the energy. Hydrogen is regarded as a primary energy carrier in the future due to the fact that it can be produced from renewable sources such as biomass, solar energy, and so on. Moreover, hydrogen can be efficiently converted to electricity for generating the car power by PEM fuel cell. Additionally, it is a clean burning fuel, which can be stored as liquid or gas distributed in pipeline during transportation.

Relating to the mobile applications in the on-board storage of hydrogen, the storage is associated with many disadvantages due to the safety, the cost of the storage handling, and the requirement of new infrastructures. To overcome the problems, associated with hydrogen storage and distribution, the on-board production of hydrogen from liquid fuels rich in hydrogen such as gasoline or methanol is the suitable option because the already existing infrastructure for fuel distribution could be immediately exploited.

Methanol is attractive for fuel-cell engines in transportation applications due to its self handling, low cost, and ease of synthesis from a variety of feedstocks (biomass, coal, and natural gas). Moreover, methanol has been recommended as the best source for hydrogen fuel among the high energy density liquid fuels, due to the presence of high hydrogen/carbon ratio—having a lower soot formation than other hydrocarbons and being converted into hydrogen at moderate temperatures, relatively low boiling point, easy storing, and the absence of carbon-carbon bonds, which are difficult to break, greatly reduces the risk for coke formation. Furthermore, hydrogen produced from methanol contains no sulfur, a contaminant for fuel cells. However, the methanol reforming process—process that produces hydrogen from methanol—still requires the optimal operating conditions for cleaning fuel production.

Hydrogen can be produced by steam reforming of methanol (SRM), partial oxidation of methanol (POM), and oxidative steam reforming of methanol (OSRM).

The reaction of oxidative steam reforming of methanol (OSRM) is

$$CH_3OH\ (g) + 1/2aO_2\ (g) + (1\text{-}a)H_2O\ (g) \rightarrow (3\text{-}a)H_2\ (g) + CO_2\ (g)$$

where $0 < a < 1$ and $\Delta H°_R = 49.5\text{-}241.8a\ kJmol^{-1}$ (25°C).

The conventional catalysts used in OSRM are copper (Cu-) and Palladium (Pd-) based catalysts. However, Cu-based catalyst has some weak points for the OSRM such as rapid deactivation of Cu-based catalyst because of the metal sintering at high temperatures. Although Pd has higher melting point than Cu and is expected to be more resistant to sintering; therefore, large amounts of CO can be formed by an active Pd-based catalyst with the undesired reaction of methanol decomposition. In addition, Pd and Cu-based catalysts are too expensive; accordingly, they are not suitable for on-board production of hydrogen. Among the potential catalysts, gold (Au) catalyst is an attractive choice. Since the metal oxide supported gold catalysts exhibit high catalytic activity in the low- temperature CO oxidation and in the water gas shift reaction (WGSR). Both of these reactions can convert CO to CO_2, which overcomes the deterioration of PEM fuel cells poisoned. However, the characteristics of gold based catalysts are different in terms of composition and/or preparation of the catalysts.

The purpose of this research is to study the oxidative steam reforming reaction of methanol over Au/CeO_2. The catalysts are prepared by deposition-precipitation and characterized by X-ray diffraction (XRD), Atomic Absorption Spectroscopy (AAS), Temperature–Programmed Reduction (TPR), Temperature–Programmed Oxidation (TPO), Transmission Electron Microscopy (TEM), Fourier Transform Infrared Spectroscopy (FT-IR), UV-vis Spectrophotometer, and BET Surface Area Measurement techniques. The influences of reaction parameters, such as effect of Au content, calcination temperature, O_2/methanol ratio, steam/methanol ratio, and reaction temperature on the catalytic performance of Au/CeO_2 catalyst for the OSRM are studied in detail.