

## CHAPTER I

### INTRODUCTION

Nowadays, the world faced with the problem of energy such as depletion of fossil fuel and the increasing of crude oil prices. From these problems, it motivated many researchers to find the alternative way of energy sources. Hydrogen is an attractive energy because it can be produced from many kinds of agricultural sources. Moreover, it provides clean energy that is environmentally friendly by using Proton Exchange Membrane Fuel Cell (PEMFC). This fuel cell can convert hydrogen to electricity for using in automobile applications.

Although hydrogen is an excellent fuel for fuel cell applications, it is associated with various strategies for on board storage of hydrogen which raises issues concerning about a dedicated filling station infrastructure, safety, and the cost of storage. To solve these problems, the production of hydrogen from liquid fuels such as gasoline or alcohol like methanol has received much attention to produce high purity of hydrogen.

Among the different sources of feedstock, methanol is a promising candidate, which has been recommended as the appropriate source of hydrogen among the high energy density liquid fuels, due to the high hydrogen/carbon ratio which reduce a propensity for soot formation higher than other hydrocarbons, low boiling point, hence it can be operated at low processing temperature, safety in handling, no sulfur containing, and the absence of carbon-carbon bond which prevent the risk of catalyst coking. Furthermore, methanol can be produced from renewable sources, so its reforming does not contribute to a net addition of carbon dioxide to the atmosphere. Generally, there are three processes available for hydrogen production using methanol as a feedstock such as steam reforming of methanol (SRM), partial oxidation of methanol (POM), and oxidative steam reforming of methanol (OSRM).

Oxidative steam reforming of methanol (OSRM), which combines steam reforming and partial oxidation, has attracted much attention because it requires less energy and reduced amount of coke produced while providing a high hydrogen yield and low carbon monoxide yield which is a poison for Pt-electrode in PEMFC.

Among various types of catalysts used in OSRM, Gold (Au-) based catalyst became a pleasing catalyst because it has been successfully used at low temperatures. This catalyst not only provides high catalytic activity for hydrogen production but also the reduction of CO which can deteriorate the Pt electrode in PEMFC. Nevertheless, it was deteriorated under the high temperature operating conditions due to the ease of sintering and agglomeration of gold nanoparticles. Hence, Au-based catalyst has limited further applications. So, the incorporation of other metals, which called bimetallic, is a good way to eliminate this problem. Among the various metals, Copper (Cu-) based catalyst has attracted much attention for preparing the bimetallic catalyst with gold because copper has the same crystals structure and similar lattice spacing like gold. hence they can form alloy easily. Many literatures found that copper can prevent the sintering of gold nanoparticles; hence, it is interesting to apply Cu to Au catalyst. Moreover, the bimetallic Au-Cu catalyst gave high catalytic activity and selectivity as compared to pure catalyst. In term of support, Ceria ( $\text{CeO}_2$ ) is an interesting support because it has high oxygen storage capacity (OSC), which allows itself to storage or release active oxygens by itself. However, ceria cannot be used under high reaction temperature. The addition of  $\text{ZrO}_2$  into  $\text{CeO}_2$  can increase the stability and specific surface area of catalyst. So, the mixed oxide support is a good chance to improve the catalytic activity of catalyst.

The objective of this research is to study the OSRM activity over Au-Cu/ $\text{CeO}_2$ - $\text{ZrO}_2$  catalysts. The influences of the main parameters; support preparation, support composition (atomic ratio of  $\text{Ce}/(\text{Ce}+\text{Zr})$ ), atomic ratio of Au/Cu, total metal loading, and calcination temperature, as the functional of reaction temperature were studied. The catalysts were prepared by deposition-coprecipitation, deposition-sonochemical and characterized by BET Surface Area Measurement, X-ray Diffraction (XRD), Temperature-Programmed Reduction (TPR), Atomic Absorption Spectroscopy (AAS), FT-Raman spectroscopy, Temperature-Programmed Oxidation (TPO), Transmission Electron Microscopy (TEM), and UV-Visible spectroscopy.