CHAPTER I
INTRODUCTION

Today's enormous energy demands are mainly fulfilled by the use of fossil fuels. Hydrogen is one of the most interesting choices of the alternative energy. Especially in transportation, it is used as a clean-burning fuel or in fuel cells to power cars, in fuel cells produce only water as a byproduct and none of the CO_2 and other pollutants obtained by burning fossil fuels as in the current fossil fuels. For transportation, proton-exchange membrane fuel cells (PEMFC) are at present the most promising option to replace the current internal combustion engine. They operate like a refillable battery—generate electricity as long as they are supplied with hydrogen fuel and oxygen (from air)—but using hydrogen still have problem in storage.

In seeking to overcome the problems associated with hydrogen storage and distribution, numerous approaches have set out to use liquid rich in hydrogen, such as gasoline or methanol as a source of hydrogen via on-board reformer. In contrast to pure hydrogen-based systems, they are compact (containing on a volume basis more hydrogen than even liquid hydrogen) and easy to store and handle without pressurization. The possibility of generating hydrogen with more than 80% efficiency by the on-board reforming of gasoline has been demonstrated. However, the process still uses fossil fuels also expensive and challenging; because it involves high temperature and needs considerable time to reach a steady operational state.

Methanol is the best candidate to be the source of hydrogen due to the absence of C-C bonds, which are difficult to break, greatly facilitates its transformation to high-purity hydrogen with 80-90% efficiency. Furthermore, it contains no sulfur, a contaminant for fuel cells. It can be converted into hydrogen at moderate temperature. Moreover, methanol can be produced from plants, renewable sources, causing no net addition of CO_2 to the atmosphere. The reaction of methanol steam reforming is

$$CH_3OH\ (g) + H_2O\ (g) \rightarrow 3H_2\ (g) + CO_2\ (g) \quad \Delta H^\circ_R = 49\ kJmol^{-1}\ (25^\circ C)$$

Hydrogen obtained by methanol reforming in current process always contains more than 100 ppm CO, which is a poison for PEMFC anode catalysts. Hence, new catalysts have been designed to produce hydrogen with high yield and only marginal amount CO is formed. The conventional copper-based catalysts have some weak points for methanol steam reforming such as quickly deactivated. Therefore, they are not suitable for on-board production of hydrogen. The non-coppers have been studied to overcome the weakness of copper-based catalyst by searching for new catalyst.

The purpose of this research is to study the methanol steam reforming reaction over Au/Fe_2O_3-Ce_2O_3. The catalysts were prepared by deposition-precipitation method and were characterized by X-ray diffraction (XRD), Temperature-Programmed Reduction (TPR), Transmission Electron Microscopy (TEM), and BET Surface Area Measurement. The influences of reaction parameters, such as Au content, calcination temperature, gas pretreatment and reaction temperature on the performance of Au/Fe_2O_3-Ce_2O_3 catalyst for the steam reforming of methanol are studied in detail.