CHAPTER I

INTRODUCTION

Fuel cells are being actively developed as alternative power generation system because they can produce electricity with substantially less impact on the environment. As mentioned previously, fuel cells are expected to replace conventional power generation systems in many of their current applications such as transportation, stationary, and portable devices. Among the various types of fuel cells, hydrogen-fueled polymer electrolyte or proton exchange membrane fuel cell (PEMFC) has been widely investigated because of their higher energy conversion efficiency than that of conventional fossil fuel power sources.

However, PEMFC operates at relatively low temperature between 80 °C and 120 °C. During the steam reforming and water–gas shift reactions via hydrogen production base on abundant fuels (natural gas, methanol, gasoline, diesel, etc.), the Pt anodes at these low temperature are often poisoned by incomplete combustion product, especially CO, reducing the overall fuel cell performance. Many literatures suggest that the CO concentration in the range of 10 to 100 ppm has the negative effect on the performance of a PEM fuel cell. Among the different possibilities, selective oxidation or preferential oxidation of CO (PROX) seems to be an effective method to remove CO from the steam and also minimizes the loss of hydrogen.

In the PROX process, CO oxidation (Eq.1.1) is the desired reaction while H_2 oxidation (Eq.1.2) should be avoided.

$$CO + 1/2O_2 \rightarrow CO_2 \qquad (1.1)$$

$$H_2 + 1/2O_2 \rightarrow 2H_2O \qquad (1.2)$$

Conventionally, PROX is carried out in the temperature range of 25 to 200 °C. At high temperature range (150 to 300 °C), CO oxidation reaction may be accompanied by reversed water–gas shift reaction (Eq.1.3) and/or CO methanation reaction (Eq.1.4), the later one consuming three moles of H_2 for each mole of CO.

$$CO_2 + H_2 \rightarrow CO + H_2O \qquad (1.3)$$

$$CO + 3H_2 \rightarrow CH_4 + H_2O \qquad (1.4)$$

Recently, the catalysts for PROX have been studied extensively, especially for gold-based catalysts which are effective for PROX reaction at much lower temperatures (even at subambient temperature, i.e. -73 °C) compared with the conventional Pt-based catalysts. This application is based on Haruta's demonstration that gold nanoparticles supported on reducible oxide supports are highly active for the CO oxidation reaction. Three main factors control the activity and selectivity of gold catalysts and also affect their efficiency in the PROX reaction: size of the gold particle, strong interaction between the gold particles and the support used, and catalyst preparation techniques. To control the strong interaction of gold nanoparticles (average gold particle sizes<3–5 nm) with the support, the suitable preparation method is strongly required. The strong interaction leads to stabilization of small gold particles through a wider contact area. The support plays an important role in catalysis by gold, providing additional sites at the interface for the adsorption of the reactants close to the gold sites.

Supported gold catalyst has been a subject of intense investigation since the report of its exceptionally high CO oxidation was active at low temperature. The suitable supports are the metal oxides which could be partially reduced, such as TiO_2, Fe_2O_3, and Co_3O_4. In earlier study, it has been reported that Au/TiO_2 was defined as a very good catalyst for CO oxidation under ambient conditions. TiO_2 support also stabilizes the metastable small gold nanoparticles against agglomeration and sintering, thereby stabilizes the active form of gold (Daté *et al.*, 2002). For another effective support, Au/Fe_2O_3 showed high activity and long life time for the selective CO oxidation in a H_2-rich gas at ambient conditions (Lin and Chen, 2005).

The purpose of this study is to develop the new catalyst (Au/Fe_2O_3-TiO_2) prepared by deposition-precipitation method for PROX reaction in the presence of H_2 rich gas for fuel cell applications. In order to understand the relationship between the catalyst properties and its activity involving selectivity, several kinds of characterization techniques must be required.