

CHAPTER I

INTRODUCTION

During the last decade, a significant increase of worldwide concern regarding to the greenhouse gases exhausting and a significant decrease of global reserved oil drive the oil price increasing year by year. Therefore, alternative energy resources for more environmentally friendly and cheaper should be utilized. Examples of utilizing alternative energy sources are the utilization of sunlight energy in photovoltaic cells or solar cells and the utilization of hydrogen energy in fuel cells. Hydrogen is the fuel of choice for the future because its supply on earth is infinite. In fuel cells, hydrogen is converted to electric power at attractive efficiencies with a negligible emission. However, hydrogen is rarely generated in nature. Therefore, primary external energy resources are employed to produce hydrogen, such as H₂O, hydrocarbon and CO₂ in steam reforming, partial oxidation and CO₂ reforming process, respectively.

The products of a hydrogen processing are a mixture of H₂, CO and CO₂. CO usually presents in concentrations of 1-20%. Minor concentrations of CO can lead the Pt-based catalyst deactivating by strongly bind on the Pt surface and results in dramatic losses of Polymer Electrolyte Membrane Fuel Cells (PEMFC) efficiency (Igarashi *et al.*, 1997). Therefore, CO must be abated from H₂ stream to concentrations of 10-100 ppm. One of the most attractive options for the removal of CO from reformat is catalytic preferential oxidation (PROX) of CO. In the process, a small amount of O₂ is added to reformat by introducing air, which preferentially oxidizes low concentrations of CO to CO₂. Ideally, the catalyst must selective oxidize 1% (10,000 ppm) of CO to less than 10 ppm without oxidizing any of the 30-70% H₂ present (Xinsheng *et al.*, 2002). Hence, many former studies have attempted to develop a new catalyst of much higher activity for selective oxidation of CO using in PEMFC applications. Catalysts for selectively oxidizing CO usually consist of a noble metal (e.g. Pt, Au, Pd and Ru) and an active oxygen provides support for the oxidizing purpose (Oh and Sinkevitch, 1993 and Rosso *et al.*, 2004).

Nowadays, Au catalyst has been increasingly received attentions from many research groups around the world. Au is generally regarded as being the least useful of the noble metals for catalytic purposes. However, in the 80s and 90s a huge growth in interest in Au as a catalyst has been observed. Probably the biggest surprise in activity has been revealed for the suitable prepared Au supported on transition metal oxides to catalyze the oxidation of CO to CO₂ at temperatures as low as -70 °C (Haruta *et al.*, 1993); thus Au may catalyze a wide variety of reactions under comparative mild conditions. Moreover, supported A zeolite catalyst has also been reported for its higher selectivity for selective CO oxidation than supported mordenite, X-zeolite and alumina catalysts (where A zeolite > mordenite > X-type zeolite > alumina) (Igarashi *et al.*, 1997). Additionally, Pt can be used to oxidize CO with high activity around 200°C, but it gives quite low selectivity for selective CO oxidation (Nimsuk, 2005). However, catalyst stability can be improved by addition the Pt metal (Zhang *et al.*, 2003). Additionally, bimetallic catalysts are extensively used in many important industrial processes and they are often referred than their monometallic counterparts in terms of catalytic activity and/or selectivity because of their unique catalytic properties.

In this study, we developed the catalyst for the preferential catalytic oxidation of CO in the presence of H₂ by using the bimetallic Au-Pt supported on A zeolite. The catalytic activities are presented in the terms of CO conversion, CO selectivity and O₂ conversion as a function of temperature, in order to find a catalyst being able to completely convert CO to CO₂ at a relative low temperature range which is suitable directly connected in the on-board H₂ generator for fuel cell applications. The incipient wetness impregnation method was used to prepare the catalysts. The results of the characterization by X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), BET surface area, H₂ pulse chemisorption, inductively coupled plasma spectrometry (ICP) and temperature-programmed reduction (TPR) are presented.