CHAPTER I
INTRODUCTION

Polymer electrolyte membrane fuel cell (PEMFC) has been developed during the last decade and become an interesting fuel cell in the application of power generation (Moore *et al.*, 2000). However, the hydrogen fuel, which is a source of power, usually contain 0.3-1% of carbon monoxide (CO) (Trimm, 2005) and the anode of PEMFC is restricted by the small amounts of this carbon monoxide in the hydrogen rich stream.

There are several approaches to remove CO, including selective membrane (Paglieri *et al.*, 2002), catalytic methanation (Xiong *et al.*, 2013), and preferential oxidation of CO in H_2-rich stream (PROX) (Deng *et al.*, 2005; Quinet *et al.*, 2008). Among the three methods, PROX appears to be the most promising one because of its ability to removed very small amounts of CO from the gaseous stream to a ppm level.

Metal nanoparticles are particularly attractive catalysts for CO oxidation, which are usually immobilized on the supports such as CeO_2 (Trovarelli *et al.*, 1999; Manzoli *et al.*, 2008; Laguna *et al.*, 2010), SiO_2 (Pedrero *et al.*, 2005; Choi *et al.*, 2008), TiO_2 (Yu *et al.*, 2007; Sandoval *et al.*, 2013), and Al_2O_3 (Oh and Sinkevitch, 1993; Yao *et al.*, 2011). Ceria is one of the most effective supports for CO oxidation due to its redox properties allowing high oxygen mobility (Avgouropoulos, *et al.*, 2008).

The catalytic activity in PROX reaction of gold catalysts on various type of oxide supports including TiO_2, CeO_2, Co_3O_4 and Co_3O_4–CeO_2 mixed oxide were studied (Liotta *et al.*, 2010). The same high CO conversion value of 76% and 80% for Au/CeO_2 and Au/Co_3O_4–CeO_2, respectively, were obtained at 100 °C. In 2006, ceria-supported gold catalysts for room temperature oxidation of CO to CO_2 were prepared by using deposition-precipitation technique (Pillai and Deevi, 2006), but the catalysts showed low surface area. In 2007, Zhang and co-workers also studied on Ag/CeO_2 catalyst prepared by impregnation method and found that silver could enhance the oxidative properties of ceria. However, Ag/CeO_2 catalyst is still inconvenience for practical use due to their low surface area and easy to oxidize when exposed to air.

In this study, poly(4-styrenesulfonic acid-co-maleic acid) sodium salt (PSS-co-MA) anionic polyelectrolytes, which have carboxylate group, will be used as a chelating ligand for stabilize CeO_2 particles and decreasing the size of oxide particles down to submicron range. This technique can produce ceria supports (nano or micrometer) with highly tunable surfaces properties. The Ag/CeO_2 was further prepared via sodium borohydride reduction and converted to Au/CeO_2 via the redox reaction in an attempt to reduce amount of gold used compared to conventional catalyst preparations.

Thus, the purposes of this work are to synthesize CeO_2 supports by using anionic polyelectrolyte as a capping agent and to prepare Ag/CeO_2 and Au/CeO_2 for use as catalyst for CO minimizing in PEMFC. The effect of synthesis methods and polyelectrolyte concentrations on CeO_2 particle size are also studied in this work. Moreover, the catalytic activity of Au/CeO_2 catalyst in CO oxidation and methanol reforming reactions are studied, as well.