CHAPTER I
INTRODUCTION

In the late 1960s, the car industry began seriously to seek ways of minimizing pollution from auto-exhausts. The US Clean Air Act of 1970 led gradually to the introduction of catalytic mufflers (auto-exhaust catalysts), the initial objective being to reduce the emission of carbonmonoxide (CO), oxides of nitrogen (NO_x) and unburned hydrocarbons (C_xH_y). The so-called three-way catalyst (TWC) has been in use since 1979. Its name reflects the simultaneous treatment by the catalyst of the two reducing pollutants, CO and C_xH_y, and oxidizing pollutant, NO_x. CO is a by-product of combustion caused by incomplete oxidation of hydrocarbons. It has a serious effect on human and animal nervous systems even in low concentrations (Tanielyan and Augustine, 1992).

At present, all over the world, increasingly severe requirements for the abatement of exhaust gas are forced by legislation as mentioned. Cerium oxide is widely employed as a promoter for automotive exhaust catalysts. The most interesting role of this component is the enhancement of the oxygen storage and release by shifting between CeO_2 under oxidizing conditions and Ce_2O_3 under reducing conditions. CeO_2-ZrO_2 mixed oxides are important new materials for the automotive exhaust catalysis because of the significant increase in the thermal stability of CeO_2, which improves the catalytic efficiency during the cold start of the engine. Moreover, the improvement of the ability to store and release oxygen (OSC) also occurs. This can widen the operating air/fuel ratio (A/F), thereby making the catalyst less sensitive to temporary variations of A/F. These properties are of paramount importance for the development of highly efficient TWCs. The partial substitution of Ce^{4+}

with Zr^{4+} in CeO_2 lattice strongly promotes bulk reduction of the solid solution in comparison to CeO_2 (Fornasiero *et al.*, 1995).

The sol-gel process is one of the most useful processes to make better catalytic materials. The term sol-gel describes the technique fairly accurately, with sol meaning a colloidal solution. A colloid is an intermediate state between being a solution and a suspension, which the particles of the solute are large enough to scatter light, but too small to settle, generally in the range between one and one thousand nanometers (Purcell, 1997). Also, the word gel means a dispersion of a solid substance in a fluid medium that behaves like elastic solid or a semi-solid rather than a liquid. The incorporation of an active metal in the sol during the gelation stage allows the metal to have a direct interaction with support; therefore the catalysts made through this method show special catalytic properties. Moreover, the sol-gel technique can produce and control the nanometer-sized and non-agglomerated particles with its specific starting materials of inexpensive inorganic metal precursors and a hydrolysis catalyst. This technique provides the ability for production of tailor-made catalysts to meet the requirements of a specific application (Cauqui and Rodriquez-Izquierdo, 1992).

The aim of this research work was to investigate the conversions of CO to CO_2 by the CO oxidation reactions on CeO_2-ZrO_2 mixed oxide catalysts prepared by the sol-gel technique, which varied the ratios of ceria to zirconia, reaction times and calcined temperatures of the catalysts. This result is useful for controlling the emissions of the exhaust gas in the automotive industries.

X-ray diffraction (XRD) measurement was used to gain more understanding of the morphology of the CeO_2-ZrO_2 mixed oxide catalysts. Temperature programmed reduction (TPR) analysis was used in this work to determine the number of reducible species present in the catalysts and to find the temperature at which the reduction occurred. It also indicated whether there was an interaction between the two metals components in the mixed

oxides. Moreover, the other characterization methods were employed including BET surface area measurement, scanning electron microscopy (SEM), FT-Raman spectroscopy and light-off temperature reaction, which the conversion starts to rise steeply, to determine the temperature at which the conversion of reactant exceeded 50 percent.