CHAPTER I
INTRODUCTION

Porous materials have attracted many researchers since they are used as catalysts and catalyst supports due to their high surface areas. According to the IUPAC definition, porous materials can be divided into three classes: microporous (<2 nm), mesoporous (2–50 nm), and macroporous (>50 nm) (An-Hui *et al.*, 2010). Among them, microporous and mesoporous materials are the most widely used for sensors, shape selective catalyst, and chemical separations. The first group of mesoporous materials were synthesized by Mobil researchers who classified mesoporous materials into three types; hexagonal (MCM-41), cubic (MCM-48), and lamellar form (MCM-50).

Cerium oxide (CeO_2) has also been widely used for many applications due to its unique redox properties and ability to store and release oxygen via conversion between Ce^{3+} and Ce^{4+} oxidation state (Pengfei *et al.*, 2008). Another word, it can be stated that high catalytic activity of cerium oxide comes from the Ce^{3+}/Ce^{4+} redox cycle. Moreover, the catalytic performance of cerium oxide can be increased by their structural properties, such as surface area and their crystal shape. Cerium oxide has been used in gas sensing, oxygen sensors, catalytic; photocatalytic activity, CO oxidation, and also used as a promoter in three-way catalysts for the elimination of toxic auto-exhaust gases (Yu Ren 2010).

Mesoporous cerium dioxide with high surface areas has been synthesized by nanocasting method with different templates which can be either soft or hard templates (An-Hui *et al.*, 2010). Soft templates (i.e. surfactant, block-copolymer) generally result in amorphous or semi-crystalline walls and poor thermal stability which can lead to a collapse of the structure during the removal of the template (Aranda *et al.*, 2009). On the other hand, hard templates (i.e. silica, carbon) present highly crystalline walls. Thus, the hard templates have much more advantages than the soft ones. Moreover, the hard templates can provide well ordered structure of frameworks, leading to high surface areas of replica. The nanocasting method to create high surface areas of mesoporous cerium dioxide needs the hard template and comprises of three main steps (An-Hui *et al.*, 2010). First, the porosity of the mesoporous template is infiltrated with a precursor solution, second, the precursor inside the pore of the template is converted to the desired substance by heat treatment, and the last step is to remove the mesoporous template by using NaOH or HF to dissolve silica template. Oxidation at high temperature is used for carbon template. The replica of the mesoporous template is obtained after removing the framework.

This research, thus, focused on the synthesis of the ordered mesoporous ceria via nanocasting method. The method used MCM-48 as a hard template which was synthesized from silatrane as a silica precursor. Optimal conditions of the nanocasting method were investigated to obtain ordered mesoporous ceria having high surface areas. Physical and reduction properties were characterized using various techniques.