CHAPTER I
INTRODUCTION

Epoxides are valuable and versatile commercial intermediates used as key raw materials for producing several useful chemical products. The epoxidation of olefin is significant and indispensable in the chemical industry. It is an oxygen transfer reaction, resulting in oxygenated molecules. Many of epoxides, such as ethylene oxide and propylene oxide, are very important to be used to make polyurethane, polyester resins, polyether polyols, flame retardants, surfactant, etc. Particularly, cyclohexene oxide is an important intermediate for the production of plasticizer, rubber, pharmaceuticals, dyes, and others.

Many kinds of oxidizing agents, e.g. hydrogen peroxide (H_2O_2), *tert*-butyl hydroperoxide (TBHP), peracid, etc., have been used in the epoxidation of cyclohexene. In many cases, H_2O_2 is preferentially selected because it is easy to handle and possess relatively high active oxygen content. In addition, H_2O_2 is inexpensive, safe, clean, and environmentally friendly (Sreethawong *et al.*, 2005). The main problem of production of cyclohexene oxide (desired product) is the formation of undesired products, which are produced by side reactions, such as 2-cyclohexene-1-ol, 2-cyclohexene-1-one, (1S,2S)-*tran*-1,2-cyclohexanediol, and others. Therefore, it is necessary to develop the new selective catalysts for solving this problem.

Up to now, homogeneous catalysts have been widely used for the cyclohexene epoxidation (O'Connell *et al.,* 1996). However, the cyclohexene epoxidation using heterogeneous catalyst has been rarely investigated. Recently, TiO_2 catalysts have been, for the first time, used efficiently for the cyclohexene epoxidation (Sreethawong *et al.*, 2005). In addition, CeO_2 was proved to be a good support for Fe catalyst used for the cyclohexene epoxidation (Reddy *et al.*, 2010); however, the use of TiO_2-CeO_2 mixed oxide as a heterogeneous catalyst for the cyclohexene epoxidation has not yet been investigated. Therefore, it is interesting to investigate the cyclohexene epoxidation over the TiO_2-CeO_2 mixed oxide.

The aim of this research was to study the cyclohexene epoxidation over mesoporous-assembled TiO_2-CeO_2 mixed oxide catalysts with various TiO_2-to-CeO_2

ratios. The catalysts were synthesized by a sol-gel method with the aid of a structure-directing surfactant and characterized by several techniques, including surface area analysis, X-ray diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM), and thermogravimetric differential thermal analysis (TG-DTA). The effects of various parameters, including TiO_2-to-CeO_2 molar ratio, H_2O_2-to-cyclohexene molar ratio, calcination temperature, and catalyst content, on the catalytic performance were studied.