CHAPTER I
INTRODUCTION

Bismuth containing materials have received great attention owing to widely uses in catalyst, cosmetic, medical, and electronic applications. Bismuth oxide itself has wide energy gab around 2.0–3.96 eV (Leonite, 2005); therefore, some bismuth oxide based materials have been explored as a novel efficient photocatalyst under visible light (Chai, 2009; Lee, 2010; Shamaila, 2011). High ion conductivity of faced center cubic phase of bismuth oxide makes bismuth oxide based material as an interesting material to be used as a solid electrolyte in solid oxide fuel cell (Sammes, 1999). Another bismuth containing material, perovskite bismuth titanate ($Bi_4Ti_3O_{12}$), acts as a promising candidate for non-volatile memory device (Park, 1999). A recent research work reported that various bismuth-doped oxide glasses act as a potential solar spectral converters and concentrators (Peng, 2009). A growing interest in bismuth is not only because of its wide range of application, but also concerned as a non-toxic material which is compromised to use instead of other heavy-metals, such as lead or mercury. Due to its signified importance in nanotechnology, it is necessary to exploit the potential precursors for modern synthesis strategy, especially in wet chemical reaction as sol-gel process and chemical vapor deposition. The challenge of bismuth containing material precursor involves the ability to control stoicheometry and reactivity of the reaction to meet the modern synthesis strategy of nanotechnology. However, bismuth alkoxide has just been recognized in the last two decades (Mehring, 2007). It can be synthesized by several methods, such as metathesis reaction (Haaland, 1993), alcohol-alcohol exchanges (Shimada, 2000), and alcohol-amine exchange (Massiani, 1991). Roger *et al.* (1992) obtained bismuth heteroleptic derivatives from alcoholysis of bismuth nitrate pentahydrate by polyols. Zevaco *et al.* (1992) successfully synthesized bismuth ethylene glycolate by heating bismuth oxide at boiling point of ethylene glycol.

Sillenite phase bismuth titanate ($Bi_{12}TiO_{20}$) has the absorption onset wavelength of visible region (around 500 nm), meaning that it has a possibility to be used under weak UV light or may be sunlight. It is currently considered as a potential catalyst in visible light catalyst (Xu, 2007; Zhu, 2010; Hou, 2011). Photocatalytic degradation (UV/TiO_2) is also receiving increased attention because of the low cost and relatively high chemical stability of the catalyst, and the possibility to use sunlight as the source of irradiation (Konstantinou, 2004). Moreover, photocatalysis does not require expensive oxidants and can be carried out under mild temperature and pressure (Aguedach, 2005). Among the photocatalyst, TiO_2 is well known to be the most active photocatalyst for organic oxidation (Hoffmann, 1995). However, bare TiO_2 has small size (about 4–30 nm), thus its particles tend to aggregate rapidly in a suspension, losing effective surface area, as well as catalytic efficiency. Therefore, inserting titanium within the cavities which exist in the framework of zeolites, for example, in titanium silicalite (TS-1), may be advantageous, because zeolites have nanoscale pores, high adsorption capacities, and ion-exchange capacities (Hong, 2001; Yamashita, 1996; Anpo, 1997). Lee *et al.* (2002) found that TS-1 performed a superior photocatalytic activity in decomposition 4-nitrophenol. Phonthammachai *et al.* (2005) also performed a high catalytic efficiency of TS-1 for degradation 4-nitrophenol. Therefore, it is a challenge to compare two potential catalysts in photocatalytic activity.

Hierarchical architecture is on a hotspot to explore the novel properties in a number of applications, such as sensor, photocatalyst, and drug carrier (Gu[a], 2011). It can be synthesized by various methods, such as hydrothermal (Kuang, 2009), electrodeposition (Gu, 2010), microwave-assisted hydrothermal (Ma *et al.*, 2011), or ethylene glycol mediate route (Ashoka, 2009; Gu[b], 2011). Among these methods, ethylene glycol mediate route has attracted a great deal of attention because it can control the morphology easily, and can prepare in the large scale.

Herein, we synthesized bismuth glycolate from inexpensive and easily available bismuth nitrate salt at low temperature. The obtained alkoxide precursor was easy to handle, facile storage, and non-toxic. The bismuth glycolate was further used as bismuth source for preparation of perovskite bismuth titanate ($Bi_4Ti_3O_{12}$). By adjusting the synthesis condition, we obtained flower-like structure of bismuth glycolate in which transformed to bismuth oxide by calcinations. The photocatalytic activity of sillenite bismuth titanate was tested and compared to TS-1 catalyst toward degrade Reactive black 5 dyes. In addition, the hierarchical $Bi_{12}TiO_{12}$ was successfully prepared via ethylene glycol mediated route.