



CHAPTER I INTRODUCTION

As the main principal for global warming, green house gases like CO₂ and CH₄ have increased about 35 % from 1990 to 2006 (Metz, 2005). Thus, using a cleaner energy carrier like hydrogen is expected to reduce green house gas emissions from the combustion of fossil fuels in stationary and mobile sources (Akiba, 1999; Schlabach and Züttel, 2001). To realize the use of hydrogen, especially for vehicles, an efficient hydrogen storage method is needed. Currently used hydrogen storage methods like compressed hydrogen and cryogenic liquid hydrogen storage have not met the target set by the DOE (The U.S. Department of energy) for hydrogen fuel transportation in either 2010 or 2015. Solid-state hydrogen storage using either porous materials or metal hydrides has emerged as a potential method.

Lithium aluminum hydride (LiAlH₄) have been considered as a promising metal hydride candidate for safe and efficient hydrogen storage because of its high gravimetric hydrogen density, 7.9 wt% hydrogen. However, it has not yet been applicable for on-board applications due to its slow kinetics and irreversibility (Schlabach and Züttel, 2001; Andreasen *et al.*, 2005).

Many research works have focused on the carbon-based nanostructures with its high surface area and porosity for hydrogen storage properties of metal hydrides (Gross *et al.*, 2008). There are a number of carbon-based nanostructures that have been used to improve the hydrogen sorption kinetic properties, hydrogen capacity, and desorption temperature. They include single-walled carbon nanotubes (SWNTs), graphite, activated carbon, aerogels, and fullerene, which was reported to enhance the dehydrogenation rate and improve the hydrogen reversible absorption for restoring hydrogen of LiBH₄ (Fang *et al.*, 2008a; Gross *et al.*, 2008; Fang *et al.*, 2008b). In addition, C₆₀ fullerene and graphite were used with NaAlH₄ and MgH₂, respectively (Berseth *et al.*, 2009; Huang *et al.*, 2007). The hydrogen desorption/absorption kinetics, hydrogen capacity, and desorption temperature of these metal hydrides were improved. In addition, effects of preparation methods and catalysts on the desorption/absorption were investigated.

It was reported that preparation methods influence the microstructure of the incorporated metal hydrides, hence, hydrogen desorption/absorption of metal hydrides. The chemical impregnation method showed to be more energy-efficient and easier in practice than the melt infiltration method. These methods also prevent grain growth during the melt infiltration process in the large pores of carbon scaffolds (Fang *et al.*, 2008b). However, the chemical impregnation method is complicated in the preparation step resulting in the metal hydrides oxidation in the drying step. Alternatively, the ball milling method was considered as it creates defects, which are disordered and less dense in the carbon scaffold, and hydrogen can diffuse through for bulk metal hydrides (Zhu *et al.*, 2010). A catalyst as metallic particles is also one variable that greatly affects the hydrogen sorption kinetic properties, hydrogen capacity, and the desorption temperature. Metallic particles such as Fe, Co, Ni, Pd, and Pt, and NbF₅ in carbon nanoscaffold were reported to improve the hydrogen desorption/absorption properties (Wu *et al.*, 2005; Luo *et al.*, 2007; Xu *et al.*, 2010; Yoo *et al.*, 2007).

From the previous studies, hydrogen storage properties depend on a type of carbon material, preparation method, and catalyst. In this work, effects of both carbon aerogels and catalysts on the hydrogen desorption/re-absorption behavior of LiAlH₄ prepared by a mechanical ball mill were further investigated. The catalysts used included Ti, TiO₂, TiCl₃, and Ni.