CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Attempts were made to improve hydrogen absorption/desorption kinetics of $NaAlH_4$ through the use of noble metals. Purified $NaAlH_4$ was mixed in the dry condition with $TiCl_3$, $ZrCl_4$, or $HfCl_4$. The sorption kinetics was observed via hydrogen pressure in a volumetric apparatus.

The results showed that different hydrogen desorption behaviors were clearly based on the added metal. It was found that $TiCl_3$ assisted on the first desorption step, which, in turn, gave the lowest desorption temperature. Among these metals, $ZrCl_4$-doping affected hydrogen capacity the most. The higher the $ZrCl_4$ loadings, the better the kinetics. However, there was an extent where the amount of loading affected the capability to improve the kinetics.

In case of hydrogen absorption, $TiCl_3$ was the most effective species in maintaining the reversibility of $NaAlH_4$ while $HfCl_4$ was the least effective one. Although $ZrCl_4$ improved the kinetics performance, the absorption capacity was reduced.

5.2 Recommendations

The hydrides are highly sensitive to water so that any exposure to air must be avoided. Experiments should be carefully carried out without any leakage for high-pressure gas. Indeed, the reactions, which occur during hydrogen absorption/desorption and gas pressurization, bring about the variation in vessel temperature, so including the high performance, temperature controller connected to a thermocouple should be outside the vessel. For precise measurements, another thermocouple should be placed in the middle position of the sample vessel and in direct contact with the sample.

For further study, highly efficient purification and loading techniques are desired. In-situ XRD and other atomic characterizations are necessary for further investigation.