16 May 2019

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Review Report

PhD Thesis " Hydrogen storage properties of magnesium hydride nanocomposites with graphite and transition metals"
by Kamil Goc,
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1. Contents of the thesis

This thesis focuses on the method to improve the hydrogen storage properties of magnesium hydride. The author investigated a new method of introducing catalytic elements by forming a thin layer of catalyst on the surface of magnesium hydride particles by using magnetron sputtering technique on powdery substrates.

Chapter 1 is the introduction of this thesis. The content of this thesis is described in this chapter.

Chapter 2 mentions the research background after reviewing previously published literatures about hydrogen storage methods. In this chapter, the reason why magnesium hydride was chosen as the subject of research is also stated.

Chapter 3 explains the experimental methodology. The measurement methods of basic physical properties and the characterization of starting materials are explained.

Chapter 4 presents the results of the experiments focused on coating of magnesium powders with catalytic layers by using magnetron sputtering technique. The observation of thin films of nickel, vanadium and niobium and analysis of the structure and phase composition were successfully conducted. Thermodynamics and kinetics of coated magnesium hydride was discussed. In addition, the hydrogenation/dehydrogenation cycling was also evaluated in this chapter.

Chapter5 presents the results of the attempt to improve the heat transfer performance of magnesium hydride. Samples of magnesium hydride with graphite flakes were prepared, and their characteristics of heat transfer enhancement were evaluated through the measurement of thermal conductivity. Finally, the hydrogenation/dehydrogenation reaction rate is evaluated through the measuring the time development of hydrogen reacted.

Chapter 6 concludes all achievements in the thesis.

2. Comments on the subject

At present, hydrogen storage materials take an important role in various energy and environmental engineering fields. The development of efficient hydrogen storage technology is important to realize the society based on hydrogen energy. Hydrogen storage capacity is one of the most important factor for the development of the hydrogen production and power generation systems. From the viewpoint of improving transient response, hydrogen incorporation and release rate are also important factor for actual use. In addition, it is a great advantage to have higher heat transfer performance, because the rapid hydrogen loading/unloading will be possible.

As mentioned above, the development of highly efficient hydrogen storage material is essential for environmental-friendly energy conversion system. Magnesium hydride is one of the most promising materials because of relatively high storage capacity, low cost and easy available. However, its applications are limited by poor reaction rate. To solve this problem is a very important issue. So, the present studies by the author, "Hydrogen storage properties of magnesium hydride nanocomposites with graphite and transition metals", is timely and suitable for social requirement. The author attempted to evaluate the hydrogen storage performance of magnesium hydride through the measurement of various physicochemical properties, which affect hydrogen storage characteristics. The author's research results make it possible to improve the performance of magnesium hydride.

3. Critical comments

1. The formulas in the text need to be numbered.

2. In chapter 4, the time needed to react of 90% of hydrogen is evaluated. How to estimate the hydrogen amount in the case of 100% reacted is not clear.

3. In chapter 4, reaction speed is employed in some graphs. What is the reason why there are cases showing reaction rate and cases not showing it?

4. In chapter 5, thermal conductivity enhancement is discussed. The variation rate of the temperature distribution is affected not only by thermal conductivity but also by density and specific heat. In order to evaluate the improvement of heat transfer, it is also necessary to obtain density and specific heat data.

5. I recommend the author to correct minor errors, after checking the whole thesis.

4. General Opinions

As mentioned in the section 2, the subject of the thesis is very timely and valuable for the development hydrogen storage equipment. After reviewing previously published literatures, the author well understood the research background and properly set the objective of PhD work. The number of literatures referred in the thesis is enough for describing the current science and engineering status of hydrogen storage materials. As mentioned in the thesis, coating of magnesium powders with catalytic layers using magnetron sputtering technology is effective for improvement of reaction rate. Moreover, improving the heat transfer performance is achieved by introducing graphite flakes. The author conducted the comprehensive experimental work to clarify the physicochemical characteristics of magnesium hydride prepared by novel method. In the thesis, evaluation methodology are described well, and close analyses are found in the chapters of results and discussions. The research results obtained from careful investigation are distinctive and excellent.

5. Concluding remarks

As already explained, the thesis submitted to Faculty of Physics and Applied Computer Science in AGH-UST by Kamil Goc is very interesting from a view-points of material science and energy engineering regarding hydrogen storage systems. The

results obtained through the comprehensive investigations regarding the hydrogen storage performance improvement are very distinctive and make a strong impact on the development of hydrogen storage systems. I think that the research achievement by the author and submitted thesis are at high level as PhD work. With honor, I would like to recommend the faculty meeting at Faculty of Physics and Applied Computer Science, AGH-UST to proceed to a public (final) presentation, and to distinguish Kamil Goc's PhD Thesis.

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