HYDROGEN STORAGE ON ACTIVATED CARBON NANOTUBES

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ABSTRACT

The invention relates to hydrogen storage on single and multi wall activated carbon nanotubes (CNT). Hydrogen is clean and renewable energy carrier and an H energy system is expected to progressively replace fossil fuels in future. Due to compressed gas, containers in vehicles have less volume than the classic ones. A clear picture of the true capacity of nanotubes for hydrogen storage is still being developed by efforts in experiment and theory. Because CNT received directly after synthesis generally have closed caps, methods for chemical activation are required to achieve their full potential. Results for SWCNT in which different forms of oxidation were used for activation and the MWCNT cleaned by PmPV used for H storage medium are presented. The whole process comprises activation of medium and hydrogen storage step in detail. Storage capacity of CNT for H can be calculated from the difference in pressure before and after equilibrium.

Keywords: hydrogen, pure energy, carbon nanotubes

Introduction

In the late 20th century, fullerenes and carbon nanotubes (CNT) were discovered as new allotropic modifications of carbon [1,2]. Since then, the knowledge of new carbon structures and its derivates grows. The variety of new species is diverse, such as endo- [3], exo- [4] and heterohedral [5] fullerenes, functionalized [6] or filled single-walled (SWNT) [7] and multi-walled (MWNT) [8] carbon nanotubes, leaving a vast field of diverse new applications to be developed [9]. SWNT are considered to be one-dimensional molecules due to their high length to diameter ratio [10], while MWNT are a collection of concentric SWNT, and as such, it is of great importance to comprehend and explore the possibilities of purifying the material on nanoscale level, with a special curiosity in size of tubes.

Recent publications concerning the hydrogen storage capacity of new nano-structured carbonic materials gave rise to the hope that energy problem of running out fossil fuels could be solved. An appropriate and safe hydrogen storage device would enormously push the application hydrogen as the clean alternative fuel. The high energy value and the lack of environmental pollutants make the use of hydrogen very attractive. The end product released by a fuel cell or by a modified combustion engine is harmless water.

This paper will give a report on the state of art hydrogen storage in carbon nanotubes. The measured storage capacities of these materials in our experiments were for 24% SWNT and 5% MWNT.

Hydrogen storage capacity is a function of several parameters like the tube diameter, alignment, length of nanotubes, and structure (multi-walled or single-walled, open or closed tubes). If the variation of storage capacity with different parameters could be quantified it would help in predicting the storage capacity and remove some of the ambiguities in the experimental results.

SEM images can serve as a good tool to find the diameter distribution. To analyze the SEM images and to get the distribution of diameters, a semi-automated digital image processing techniques have been used. The technique of digital image processing is routinely used to determine the distribution of particle sizes.

Characterization of SWNT and MWNT was made on SEM (JEOL JSM 6460 LV Japan, 2003) and ESR measurements were performed on a Varian X-band spectrometer with 100 kHz modulation at room temperature.

The adsorption – desorption cycles and hydrogen capacity were done on a mass spectrometer MS-1-MT in local design.

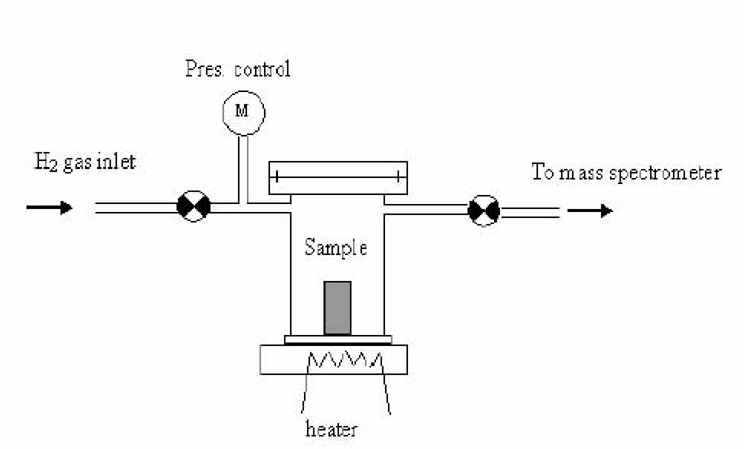

Figure 1.Shematic diagram of chamber for adsorption hydrogen

Measured mass of SWNT= 0,0732 g
Measured mass of MWNT= 0,3215 g
Nanotubes were filled with hydrogen up to pressure to 3 atm.
For calibration were used $LiAlH_4$.

Reactions

3 $LiAlH_4 \rightarrow Li_3AlH_6 + 3H_2 + 2Al$
$Li_3AlH_6 \rightarrow 3LiH + 3/2\ H_2 + Al$
$LiH + Al \rightarrow LiAl + ½\ H_2$

Final reaction: 3 mol $LiAlH_4 \rightarrow$ 6 mol H_2 + (3 LiAl)

$Mr(LiAlH_4)$= 38 g/mol

Measured mass of $LiAlH_4$ 0,53g produces mass of hydrogen 0,055g

Pressure in the chamber, which released H_2 in the combustion reaction of $LiAlH_4$,p = 0,63 atm H_2

1g $LiAlH_4 \rightarrow$ 0,104 g H_2
1g SWNT→ 0,314 g H_2
1g MWNT→ 0,053 g H_2

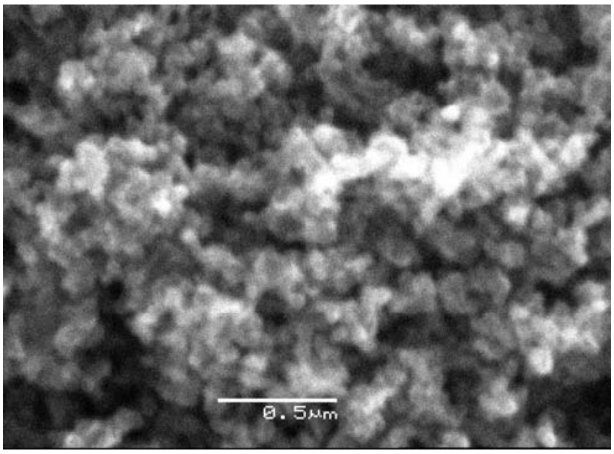

Figure 2. SEM image of unpurified SWNT

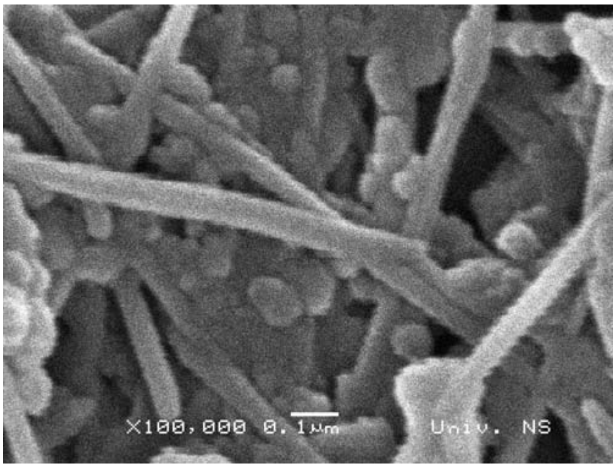

Figure 3. MWNT after PmPV purification.
The content of nanotubes to impurities comparing to acid treated ones is higher.
The diameter of MWNT appears to be uniform

For pressure higher than 1 atm hydrogen storage is confirmed in SWCNT. The storage capacity probably can be increased by applying higher hydrogen pressures or by lowering the temperature. In future studies, an emphasis should be given to develop reliable purification and characterization methods for carbon nanotubes [11].

Conclusion

In this work, we have shown that carbon nanotubes have good properties for hydrogen storage. The experiment shows that CNT possess possibilities for multi adsorption-desorption cycles, without material damage.

Acknowledgments

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