

# **FINAL TECHNICAL/SCIENTIFIC REPORT**

## **1. Award Information**

Award Number: DE-FG07-05ID14697

Awardee Name: University of Missouri System, Columbia Project

Awardee Project ID. 00003521

Project Title: Hydrogen Storage in Nano-Phase Diamond at High Temperature and Its Release

Principal Investigator: Tushar K Ghosh

Date of Report: October 13, 2008

Period covered by the Report: Jul 1, 2005 - Jun 30, 2008

## **2. Distribution limitations:**

None.

## **3. Executive summary**

The objectives of this proposed research were: (1) Separation and storage of hydrogen on nanophase diamonds. It is expected that the produced hydrogen, which will be in a mixture, can be directed to a nanophase diamond system directly, which will not only store the hydrogen, but also separate it from the gas mixture, and (2) Release of the stored hydrogen from the nanophase diamond. Although the main objective was to evaluate nanosize diamond powders, however, Both nano and micron size diamond powders were used in the study. Both the powders were doped with boron and irradiated in a neutron flux to enhance their hydrogen storage capability. Nanophase diamond powders were also exposed to hydrogen plasma to study the hydrogen loading mechanisms. The maximum storage capacity observed in nanophase diamond was 1.47 wt% and it was about 3 wt% in microsize diamond powders. A significant difference in the boron-doped, irradiated samples was not observed. About 30% of the doped boron interacted with neutrons when irradiated in a fluence of  $4.3 \times 10^{18}$  n/cm<sup>2</sup>. A higher irradiation time may be necessary to further interact with boron. Although a significant amount of loaded hydrogen could be released from diamond by heating at 400 C, the release temperature could be reduced significantly by applying a current across the sample during heating.

#### **4. A comparison of the actual accomplishments with the goals and objectives of the project.**

The project was directed at exploring loading of hydrogen and its release from nanophase diamond powders. We were able to address all the objectives stated in the proposal. The results were mixed.

Two students were completed their PhD work based on the proposed work in the proposal. Also, the project provided research opportunities for 3 undergraduate students. A number of articles were published in ANS Transactions. Two additional manuscripts relating to the above work are in preparation, and these will be submitted to appropriate journals in the post award period.

#### **5. Summary of project activities for the entire period of funding:**

The project activities included graduate student recruitment, advisement, research associated with the project, preparation of journal articles, presentations and discussions at technical meetings, and periodic reports to the sponsor.

The project has resulted in a number of technical articles that were presented in ANS meetings and are also published in ANS Transactions. This work is being continued in the post-award period, and two additional manuscripts are in preparation.

#### **6. Publications (Journal Articles):**

Hydrogen Storage in Nanosize Diamond Powder-Surface Modified by NaF, David Leal Escalante, Angel Velez, Mark A. Prelas, and Tushar K. Ghosh, ANS Transactions, 92, 90-91, 2005.

Use of Hydrogen Plasma for Storing Hydrogen in Nanophase Diamond Powder, Zach Houston, Tushar K. Ghosh, and Mark A. Prelas, ANS Transactions, 92, 88-89, 2005.

Enhanced Absorption of Hydrogen in Modified Diamond; Applications in Space Exploration and Radiation Shields, A. Mendez, T. K. Ghosh, M. A. Prelas, et al., MSGC, 2007.

Modification of Nano and Micro-Phase Diamond Powder for Enhancement of Hydrogen Storage, A Sotomayor-Rivera, Ph. D. Dissertation, University of Missouri-Columbia, 2007.

Hydrogen Storage in Modified Nanodiamond, Angel Valez, Ph.D. Candidate Nuclear Engineering, University of Missouri-Columbia, 2008.