IV.H.3 HGMS: Glasses and Nanocomposites for Hydrogen Storage*

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*Congressionally directed project

Objectives

The ultimate vision of this project is to develop glass-based materials with structural properties that would make them promising candidates for use in H-storage: either as material for glass microspheres or for sponge-type storage.

- This is an extensive research project in physics and chemistry of glasses and of glass-based nano-crystalline materials.
- It will fill gaps in the current understanding of these very complex materials.
- It will shed more light on nucleation and crystallization phenomena in glass matrices, which could extend their technological applications.

Technical Barriers

This project addresses the following technical barriers from the Hydrogen Storage section of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) System Weight and Volume
(B) System Cost
(D) Durability/Operability

Technical Targets

This project is conducting studies of glasses and of glass-based nano-crystalline materials. Insights gained from these studies will be applied toward the design and synthesis of hydrogen storage materials that meet the following DOE 2010 hydrogen storage targets:

- Weight and Volume: 0.045 kg H_2/kg system; 0.028 kg H_2/L system
- Cost: $4/kWh net

Approach

The most desirable candidates for hydrogen storage are systems which do not interact chemically with hydrogen and possess high surface area to host substantial amounts of hydrogen. From this point of view, glasses built of a disordered network with ample void spaces, which are permeable to hydrogen and glass-derived nanocomposites, hybrids of glass and nanocrystals, appear to be promising candidates. Other essential advantages of glasses include simplicity of preparation, flexibility of composition, chemical durability, non-toxicity and mechanical strength, as well as low production costs and environmental friendliness.

This project will challenge to extend the concept of using glass-based materials as hydrogen storage media. The focus will be on research of specific glass compositions with emphasis on their fabrication process and characterization using multi-technique experimental approach. The endeavor is to show ways how to tailor the structure of disordered amorphous networks in selected glasses by taking advantage of controlled nucleation and crystallization phenomena and by transforming them into glass-crystal hybrid complex nanocomposites. The ultimate goal of this project is the successful development of glass-derived composite materials with structural properties that would make them promising candidates for potential use as hydrogen storage media: either as material for glass microspheres or for sponge-type storage. Moreover, this research will fill gaps in the current understanding of a very complex group of materials – glasses – and will shed more light on nucleation phenomena in glasses which will extend the existing variety of their technological applications.

Accomplishments

- Project begun in January 2010.
- This is a brand new project and requires the establishment of two new laboratories. The

execution of the project is conditioned by laboratory reconstruction/adaptation and by purchase of state-of-the-art experimental instrumentation.

- The project is composed of several experimental tasks which are sequential and depend on the completion of the new laboratories that is currently in its final phase.

Future Directions

Experimental work is scheduled to commence in September/October 2010.

FY 2010 Publications/Presentations

Presentation at DOE Annual Merit Review & Peer Evaluation Meeting, June 7–11, 2010, Washington, D.C,. HGMS: Glasses and Nanocomposites for Hydrogen Storage.