III.F.4 New "Grand Challenge" Independent Projects

In addition to the three Hydrogen Storage Centers of Excellence, the DOE solicited independent projects from industry and universities on new materials and concepts for hydrogen storage, including off-board storage. The following pages contain brief summaries of the work proposed by each independent project chosen to receive an award. Subject to congressional appropriations, further details on each project will be provided in the 2005 Annual Progress Report.

A Radically New Method for Hydrogen Storage in Hollow Glass Microspheres

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This project proposes to develop and demonstrate the capability for meeting the DOE 2010 hydrogen storage system-level targets with hollow glass microspheres (HGMS) combined with photo-induced hydrogen diffusion. Glass microspheres are made of silicate glasses, common materials which are plentiful, cheap, recyclable, and non-toxic. This project will address the slow kinetics of hydrogen release of hollow microspheres, creating an opportunity for development of a new approach to on-board vehicular storage and utilization of hydrogen to meet DOE targets. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Hydrogen Storage in Novel Molecular Materials

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The Carnegie Institution of Washington proposes to develop and demonstrate reversible CH_4- and H_2O-based hydrogen storage clathrate materials with at least 7 wt.% materials-based gravimetric capacity and 50g H_2/L materials-based volumetric capacity, with potential to meet DOE 2010 system-level targets. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Electron-Charged Graphite-Based Hydrogen Storage Material

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GTI proposes to develop a new low-cost graphite-based structure with a novel electron charge device that is able to store hydrogen to meet the DOE storage target of 9 wt%. This new concept involves modification of low-cost graphite for hydrogen storage using incorporation of key metals and an electron charge device that will enhance electron charge balance, hydrogen storage capacity, and hydrogen charge/discharge cycle life. After the initial proof-of-feasibility phase, performance optimization will be conducted and production costs and processing will be analyzed for commercial manufacture. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Development of Cost-Effective and Reliable Off-Board Hydrogen Storage Technology

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GTI proposes to analyze available technology options for bulk storage of hydrogen (H_2) for vehicle fueling stations through detailed modeling of compressed H_2 and both above ground and direct buried underground liquid hydrogen (LH_2) tank storage. The project will address important issues that arise when considering fueling station storage such as capital cost, operating costs, footprint, fuel capacity and safety. The objectives are to determine the economics to store LH_2 and compress (cryogenic liquid compression by means of a positive displacement pump) and dispense H_2, and to demonstrate that direct underground burial also provides operational and safety benefits. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Novel Metal Perhydrides for Hydrogen Storage

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Michigan Technological University (MTU) proposes to create iron and copper perhydrides using microwave plasma generation of hydrogen ion species and high-pressure per-hydrogenation of metal hydrides and/or their intermediate species. The proposed novel metal perhydrides have the potential to be more reactive than conventional metal hydrides and have the potential to release more hydrogen. The perhydrides of copper and iron, the most promising candidates, are relatively inexpensive and can be easy to regenerate in an energy production cycle. MTU also plans to characterize the resulting products and investigate the optimized synthesis parameters of the most promising metal perhydrides, which have the potential to meet DOE 2010 system-level targets. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Development of Regenerable, High-Capacity Boron Nitrogen Hydrides for Hydrogen Storage

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RTI proposes to develop synthesis and hydrogen extraction processes for nitrogen/boron hydride compounds (particularly aminoborane [NH_3BH_3] with 19.6 wt% of hydrogen) that will permit exploitation of the high hydrogen content of these materials for on-board hydrogen storage meeting DOE targets. The project plans to address key challenges facing the use of aminoborane as a medium for hydrogen storage: inexpensive aminoborane synthesis processes and an efficient system for extracting available hydrogen. This entails investigating whether an aminoborane synthesis process can use the amorphous boron nitride (BN) byproduct as a primary starting material; an efficient recycle loop could be set up for converting the BN back into the starting hydride. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Nanostructured Activated Carbon for Hydrogen Storage

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SUNY-Syracuse proposes to develop a novel methodology for the preparation of nanostructured activated carbon for hydrogen storage and demonstrate attainment of 6% (by weight) hydrogen storage capacity. They also plan to demonstrate sustainability of attained sorption capacity and designs to scale the process to prepare kilogram quantities of the material. They also plan to extend hydrogen sorption capacity to 8% (by weight). *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Hydrogen Absorption in Gamma Irradiated Carbon and Other Materials

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TOFTEC proposes to investigate the adsorption/absorption of hydrogen gas in gamma irradiated samples of graphite, boron nitride, carbon nanotubes, nanofibers, and other materials (e.g., resins, zeolytes). The materials and processes leading to the largest absorption per unit weight will be characterized and developed. Based on an initial proof-of-feasibility phase, future efforts will involve analyses of processes and materials synthesis for scale-up and cost reduction. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

A Synergistic Approach to the Development of New Classes of Hydrogen Storage Materials

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The University of California-Berkeley proposes to develop and demonstrate new types of hydrogen storage materials with at least 6 wt.% materials-based gravimetric capacity and with potential to meet DOE 2010 system-level targets. Materials under consideration include nanoporous polymers, nanoporous coordination solids, destabilized high-density hydrides, nanostructured boron nitride and magnesium and metal alloy nanocrystals. Theoretical work includes first-principles determination of hydrogen binding energies and development of theory on boron nitride-containing nanostructures. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Materials for Hydrogen Storage with Unsaturated Metal Binding Sites

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The University of California, Santa Barbara proposes to develop hydrogen storage materials for reversible on-board applications with hydrogen binding energies intermediate between physisorption and chemisorption. Initial materials under consideration include novel multi-dihydrogen complexes and nanoporous hybrid materials and substituted VSB-5 derivatives. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Effects and Mechanisms of Mechanical Activation on Hydrogen Sorption/ Desorption of Nanoscale Lithium Nitrides

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The University of Connecticut proposes to develop a fundamental understanding of the effects and mechanisms of mechanical activation on hydrogen storage capacity and sorption/desorption processes of nanoscale Li_3N. Researchers plan to produce a novel, mechanically activated, nanoscale Li_3N-based material that is able to store and release ~10 wt% hydrogen at temperatures below 100°C. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

New Concepts for Optimized Hydrogen Storage in MOFs

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The University of Michigan, Ann Arbor proposes to develop new metal-organic framework structures (MOFs) with extremely high surface areas capable of meeting DOE 2010 guidelines. The research also plans to improve mass and volumetric H_2 density in MOFs with interpenetration and inclusion strategies. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Hydrogen Storage in Novel Organic Clathrates

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The University of Missouri-Columbia proposes to develop and demonstrate organic or organometallic clathrates with hydrogen storage capacities of greater than 4 wt% (on a materials basis). Such clathrates can exist as stable crystalline solids under ambient conditions when fully loaded with H_2 and offer the potential to achieve DOE hydrogen storage system-level targets. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*

Carbide-Derived Carbons with Tunable Porosity Optimized for Hydrogen Storage

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The University of Pennsylvania and Drexel University propose to develop and demonstrate reversible hydrogen storage in carbide-derived carbons (CDC) with tunable nanoporosity. They plan to determine the optimum pore size for hydrogen storage using experiment and theory, and to design a CDC-based hydrogen storage material that meets the DOE performance targets and is commercially viable. *(Note: Subject to congressional appropriations, work on this project is anticipated to begin in FY 2005.)*