Electron-Charged Graphite-Based Hydrogen Storage Material

Chinbay Q. Fan
Gas Technology Institute
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Project ID #
STP 45

This presentation does not contain any proprietary or confidential information

Overview

Timeline

- 4 year project waiting for DOE contract

Budget

- Total project funding
  - Needs DoE approval
- Funding received in FY04: $0
- Funding for FY05 (?)

Barriers

- **Cost: use inexpensive graphite**
- **Weight and volume: use high density graphite**
- **Efficiency: add electron charge to increase storage rate**
- **Durability: use electron charge to control cycles**
- **Refueling Time: use electron charge to increase fueling rate**
- **Codes and Standards**
- **System Life-Cycle Assessments**

Partners

Superior Graphite Co.
Chicago, Illinois

gti®

Objectives

- Develop a new concept with graphite-based materials to store hydrogen on-board vehicles and for applications
- Investigate and optimize low-cost natural flake graphite materials with modifications to increase storage
- Investigate electron charge device control to increase hydrogen storage to reach DOE 2010 targets (6 wt%)

Approach

1. Expansion of the graphite layers and generation of small particles to allow access for hydrogen adsorption
2. Metal intercalation to increase back-donated electron charges onto the carbon, so the hydrogen adsorption becomes combined physisorption and chemisorption.
3. Addition of electron charge to increase hydrogen adsorption
4. Study discharge control characteristics

Several Methods to Donate Electrons

1. Electrochemical Methods

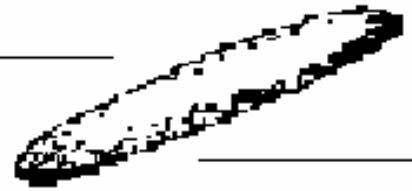
2. Metal Intercalation

3. Electrostatic Charges

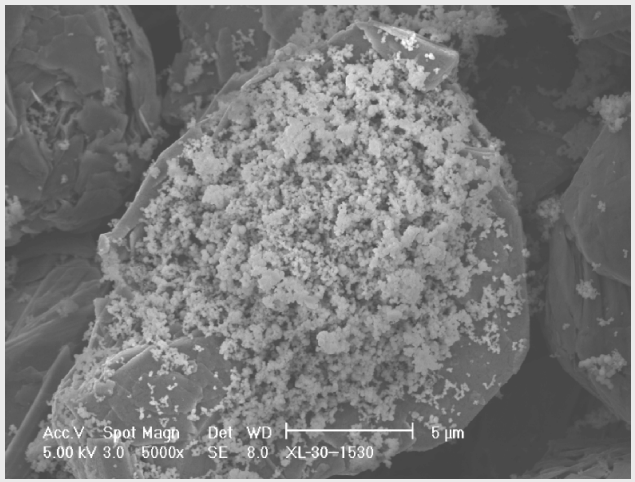
Advantages of Graphite as Substrate for Hydrogen Storage

- Graphite is inexpensive and stable
- Graphite is well-studied for metal intercalation in battery applications
- Exfoliated graphite particles have physical space for hydrogen, but after metal intercalation, also have chemical sites for hydrogen storage
- Graphite particles have various shapes for packing advantages in hydrogen storage reservoirs
- Graphite also subject to other proprietary modifications

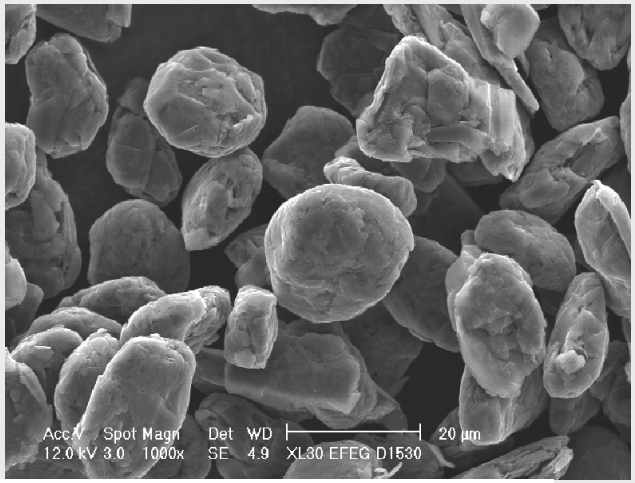
Graphite Shapes Affect Hydrogen Storage

Term	Shape
Cylindrical	
Discoidal	
Spherical	
Tabular	
Ellipsoidal	
Equant	
Irregular	

Superior Graphite Modifications



Graphite Particle Additions / Coatings



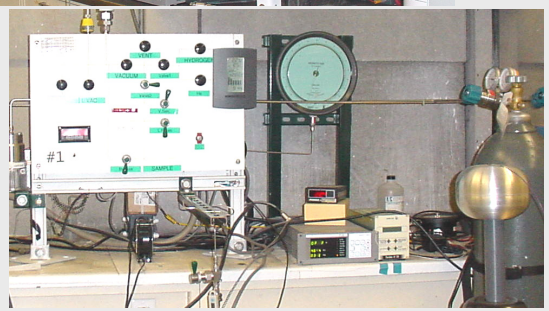
Graphite Particle Shape Modifications

Concept of Electron-charged Graphite Particles

- A proprietary method will be used to manipulate electron charges on the graphite particles to add electron donor sites for hydrogen storage
- Expanded graphite particles have increased space between graphite layers using metal intercalation and other methods that can hold the space open

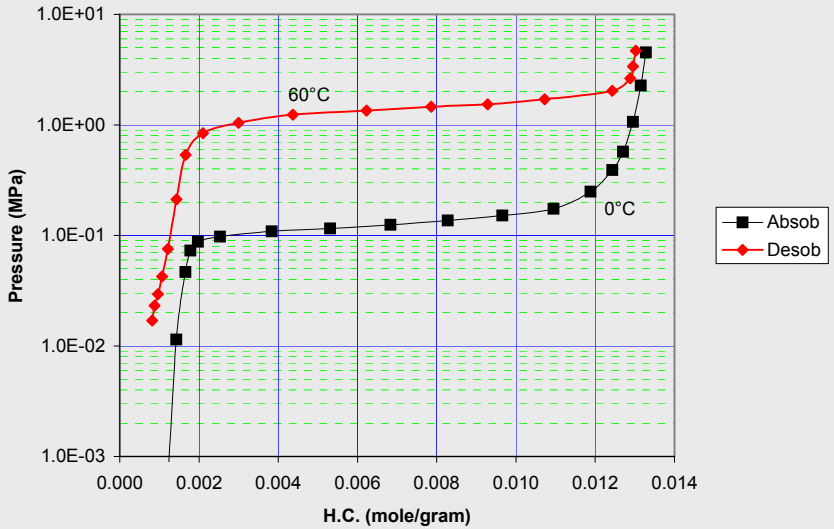
GTI Facilities

Hi Temp Ovens



3 Sievert Stations

Cahn TherMax 500 TGA



Metal Hydride Results

Superior Graphite Facilities

Peter R. Carney Technology Center
Chicago, IL

BET Surface Area

Graphite Resiliency Test

Project Schedule/Work Plan

Year 1: Proof of Feasibility

Task 1-1. Select materials and conduct graphite-processing steps

Task 1-2. Test and evaluation cycle for hydrogen storage

Task 1-3. Calculate and compare the theoretical charge sufficient for the 2015 DOE hydrogen storage target

Task 1-4. Project Management and Reporting

Year 1 Project Responsibilities

GTI

- GTI will work with Superior to select graphites, intercalation metals, and other additives
- GTI will assemble an electron charger device to make a storage test system
- GTI will test & evaluate samples and methods

Year 1 Project Responsibilities

Superior Graphite

- Superior will process and prepare various samples of the modified graphite with intercalated metals.
- Superior will analyze graphite properties after intercalation.
- Superior will provide analysis and guidance from their knowledge of graphite

Hydrogen Safety Concerns

- Hydrogen Storage Material
- Moderate Pressure Hydrogen

GTI is committed to
provide a safe work environment
for all employees and visitors.

Moreover, it is committed to
be in compliance with all
federal, state and local safety regulations.

GTI Safety Procedures

- Limit testing to very small amount (10's grams solid, 1/10 m^3 gas)
- Apply JIS (Japan Industrial Standard) H 7201
- Always handle hydrogen storage materials in a inert gas purged glove box.
- The pressure of the test system should not exceed the moderate pressures
- Vented hoods with non-sparking vent blowers
- Combustion gas sensor alarms in lab