B1

Development of high capacity metal hydrides and hydrogen storage systems

In this study, interstitial hydrides, MgH_2-based composites hydrides, and metal borobydrides will be developed for room temperature and high temperature applications. The details of the final targets are:

- Reversible gravimetric & volumetric storage density : > 8 wt% and > 100 kgH_2/m^3 for HT applications; > 3 wt% and > 120 Kg/m^3 for RT applications
- Dehydrogenation/hydrogenation conditions: < 300℃ between 1 and 100 bar H_2 (HT applications) and < 80℃ between 1 and 50 bar H_2 (RT applications)
- Hydrogenation reaction kinetics : > 90 % of maximum capacity in 1 hour (HT applications) and in 2 minutes (RT applications);
- Cycle life : > 70% of initial capacity after 100 cycles

Goal

Develop new materials which can reversibly store hydrogen at room temperature as well as high temperatures

- Synthesis, characterization, & improvement in sorption properties of Mg-based composites and metal borohydrides for high temperature applications
  - Synthesis, characterization, and sorption properties enhancement of metal borohydrides and their composite
  - Development of Mg-baed composites and their manufacturing process
- Design of new interstitial hydrides and demonstration of production techniques of hydrogen storage alloys for room temperature applications
  - Design of materials for enhanced hydrogen storage properties and development of microstructure control techniques
  - No less than tens of kg/batch scale, hydrogen storage density of no less than 120 kg H_2/m^3

Objective

- 1st year
  - Synthesis of metal borohydrides with > 8 wt% storage capacity
  - Design of Mg-based composites and development of their processing technique
  - Enhancement of hydrogen storage capacity of new interstitial hydrides (> 2.8 wt%)
- 2nd Year
  - Synthesis of reactive hydride composites including metal borohydrides
  - Improvement of storage capacity of Mg-based composites by nano structuring
  - Enhancement of hydrogen storage capacity of new interstitial hydrides (> 2.9 wt%)
- 3rd Year
  - Improvement in hydrogenation kinetics of metal borohydrides with catalyst
  - Enhancement in sorption properties of Mg-based composites
  - Enhancement of hydrogen storage capacity of new interstitial hydrides (> 3.0 wt%)
- 4th Year
  - Long-term sorption cycle test and enhancement of cycle performance
  - Process optimization and development of SHS process technique
  - Demonstration of hydrogen storage alloy production techniques

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Strategy

Interstitial hydrides	Mg-based composites	Metal borohydrides
Alloy design	Mg-based composite design	Materials design & synthesis
Property evaluation	Property/process optimization	Design hydride composites
Process development	Process development	Kinetics improvement
Storage tank demonstration	SHS process development	Cycle performance enhancement

Outcomes & benefits

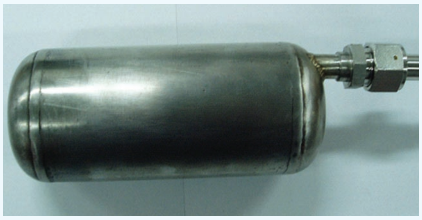
- Application to industrial/HEV Ni-MH batteries, various off-board fuel cells, and on-board fuel cells for hybrid automobiles, submarines, ships etc. by procuring production techniques of hydrogen storage alloys which are emerging as a promising alternative for applications in various fields.
- Application to mobile and stationary hydrogen storage systems for internal combustion engines
- Long-term mass power storage systems for renewable energy systems
- Application to heat storage systems

Publications (2nd stage)

Patent		Theses							Proceedings		
		domestic			foreign			total sum			
domestic	foreign	SCI	Non SCI	sum	SCI	Non SCI	sum		domestic	foreign	sum
10/11	2/0		4	4	31		31	35	28	23	51

- Publications

1. Sun-Ah Jin, Young-Su Lee, Yoonyoung Kim, Jae-Hyeok Shim, Young Whan Cho, "Reversible hydrogen storage in $LiBH_4$-MH_2 (M = Ce, Ca) composites ", J. Phys. Chem. B, 112, 9520-9524, 2008.
2. Jeong-Hyun Yoo et al. "Effects of desorption temperature and substitution of Fe for Cr on the hydrogen storage properties of $Ti_{0.32}Cr_{0.43}V_{0.25}$ alloy", Int. J. of Hydrogen Energy, 32 (2007) 2977-2981.
3. Jae-Hyeok Shim, Ji-Woo Kim, Young Whan Cho, Method for manufacturing transition metal boride powder, US Patent 7,541,013.



MH tank with 1.4 kg of HSA

KIST/PAL Beamline 10B (In-situ measurement)