

Helmholtz Initiative “FuncHy”

Functional Materials for Mobile Hydrogen Storage

Introduction

Rüdiger Bormann, GKSS Research Centre, Geesthacht

2nd Intl. Workshop 2007

FZK, Karlsruhe, November 21, 2007

Challenges of a Future Hydrogen Economy

Hydrogen generation by renewable energy sources



Hydrogen separation and cleaning



Hydrogen transport and infrastructure



Hydrogen storage



Use of hydrogen in fuel cells



Safety aspects

Network of Competence: Hydrogen Technology for Mobile Applications

NEW: EU FP7 NANOHy
Novel Nanocomposites for Hydrogen Storage Applications

EU FP6 IP NESSHY:
Novel Efficient Solid Storage for Hydrogen

EU FP6 IP STORHY:
Hydrogen Storage Systems for Automotive Applications

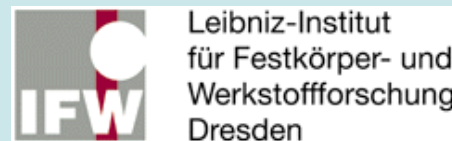
NEW: EU FP6 MC RTN COSY:
Complex Solid State Reactions for Energy Efficient Hydrogen Storage

EU FP6 MC RTN HYDROGEN

EU FP6 STREP MOREPOWER:
Compact Direct (M)Ethanol Fuel Cell for Portable Application

Helmholtz Virtual Institute
Asymmetric Structures for Polymer Electrolyte Fuel Cells

HGF Initiative
Functional Materials for Mobile Hydrogen Storage



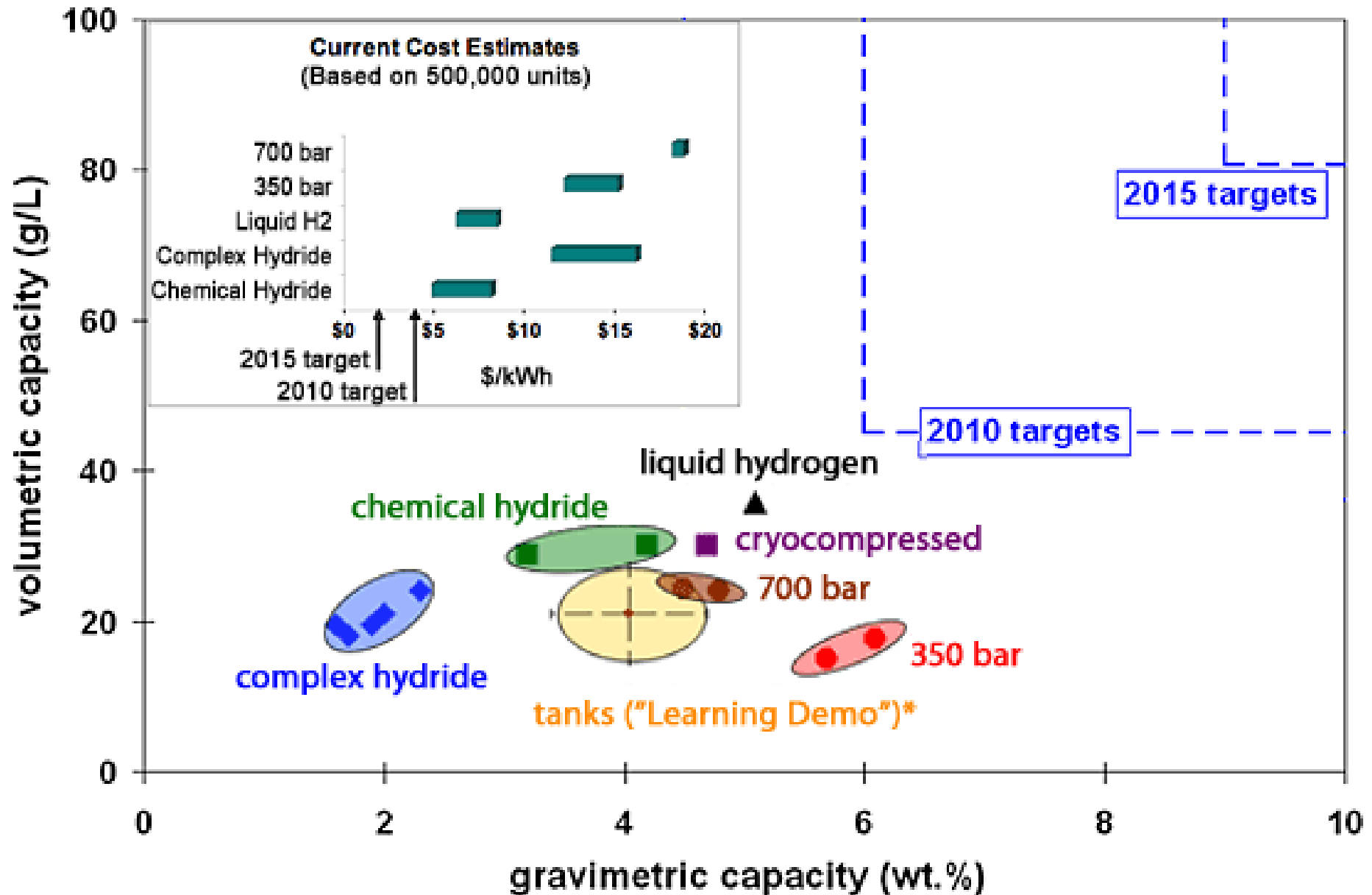
Associated Partners of the Helmholtz Initiative

TU Hamburg-Harburg, Univ. Uppsala, TU Denmark, Univ. Aarhus, IFE Norw., MPI Kohlenf., MPI Metallf., BMW AG, DaimlerChrysler AG, Volkswagen AG, Adam Opel AG/General Motors, DLR IfK, GKSS IfP, FZK IKET

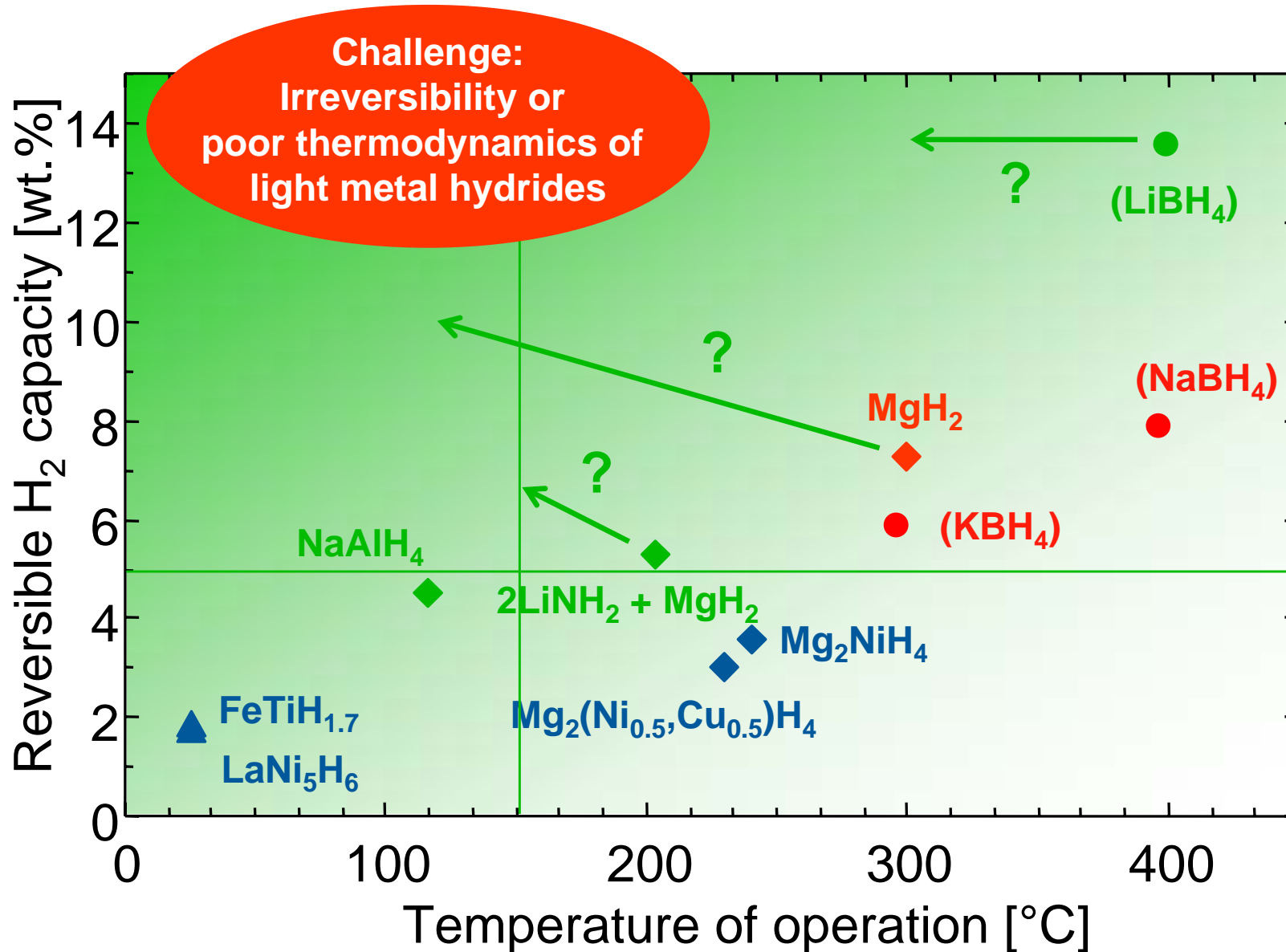
- Development of **novel hydrogen storage materials** with a reversible hydrogen capacity of more than **5 wt.%**
- **Desorption temperatures of ≤ 150 °C** for combination with a new generation of PEM fuel cells and combustion engines
- **Optimisation of ab- and desorption kinetics** of storage materials
⇒ sorption kinetics not rate limiting for properties of whole storage system
- **Economic production routes** for storage materials

cf: EU IP STORHY, Shell Global Solutions,
Japanese „New Sunshine Project“, US DOE system targets

Current Status of H Storage Systems (DOE 8/2007)



Overview: Metal Hydrides for Hydrogen Storage



FuncHy

Materials

Alanates (task leader Dr. Maximilian Fichtner, FZK)

Borohydrides (task leader Dr. Philippe Mauron, EMPA)

Amides (task leader Dr. Wiebke Lohstroh, FZK)

Reactive Hydride Composites (task leader Dr. Martin Dornheim, GKSS)

Cross Cutting Tasks

Thermodynamic and Kinetic Characterisation

(task leader Dr. Oliver Gutfleisch, IFW)

Combinatorial Search for Hydrogen Storage Materials

(task leader Dr. Bernard Dam, VU)

System Integration of Selected Hydrogen Storage Materials

(task leader Dr. Nico Eigen, GKSS)

FuncHy started in 2005, budget 363T€/year

1st Intl. Workshop Sept. 2006, GKSS, Geesthacht
⇒ specification of the research topics and tasks

Sept. 14th, 2007, **evaluation** of the results
⇒ FuncHy will be financed till 2009 ?

2nd Intl. Workshop Nov. 2007, FZK, Karlsruhe
⇒ hydrogen related topics, in particular from associated partners

„FuncHy“-Partners

Helmholtz Centres:

GKSS Research Centre Geesthacht GmbH (GKSS), Institute for Materials Research, Prof. R. Bormann,
Forschungszentrum Karlsruhe GmbH (FZK), Institute for Nanotechnology, Prof. H. Hahn

Core Partners:

Leibniz Institute for Solid State and Materials Research Dresden (IWF),
Institute for Metallic Materials, Prof. L. Schultz

Empa, Switzerland, Materials Science & Technology, Hydrogen & Energy, Prof. A. Züttel

Vrije Universiteit, Amsterdam, Netherlands (VU), Condensed Matter Physics, Prof. R. Griessen

Associated Partners:

Hamburg University of Technology, Institut Verfahrenstechnischer Apparatebau, Prof. J. Hapke

University of Uppsala, Sweden, Materials Physics, Prof. B. Hjörvarsson

Technical University of Denmark, Centre for Atomic-Scale Materials Physics, Prof. J. Nørskov

University of Aarhus, Denmark, Dr. Torben Jensen

Institute for Energy Technolog, Kjeller, Norway, Dr. B. Hauback

Max-Planck-Institut für Kohlenforschung, Mülheim/Ruhr, Prof. F. Schüth

Max-Planck-Institut für Metallforschung, Stuttgart, Dr. M. Hirscher

DaimlerChrysler AG, Dr. J. Zieger

BMW AG, Dr. J. v. Wild

Volkswagen AG, Prof. H. Ferkel

Adam Opel AG / General Motors, Dr. U. Eberle

German Aerospace Centre, Stuttgart, Institute for Vehicle Concepts, Prof. H. Friedrich

GKSS Research Centre Geesthacht GmbH, Institute for Polymer Research, Prof. V. Abetz

Forschungszentrum Karlsruhe GmbH, Institute for Nuclear & Energy Technologies, Prof. T. Schulenberg

Project Tasks and Targets I.

Materials

Alanates (task leader: Maximilian Fichtner, FZK)

- Preparation by **wet chemistry** and **ball milling**, characterisation
- cost effective **catalysts**
- Clearing of **reaction steps** and **mechanisms, modelling**

Borohydrides (task leader Andreas Züttel, EMPA)

- **Chemical preparation**, characterisation
- Identification of intermediate steps during **decomposition and catalysis**
- Preparation and characterisation of **Borohydride thin films**

Amides (task leader Wiebke Lohstroh, FZK)

- Preparation by **wet chemistry** and **ball milling**, characterisation
- Identification of **phase composition** during reaction
- Clarification of **reaction mechanisms**
- **Reduction of ammonia** release compared to non-doped composites

Reactive Hydride Composites (task leader Martin Dornheim, GKSS)

- Preparation, characterisation of **different composites** by ball milling
- Requirements for hydrogen ab- and desorption of **composites. catalysis**
- Thermodynamics and structural characterisation

Project Tasks and Targets II.

Cross cutting tasks

Thermodynamic and Kinetic Characterisation

(task leader Oliver Gutfleisch, IFW)

- Round robin and **measurement standard** for thermodynamic characterisation
- **Data base** for properties of storage materials based on complementary methods of investigation

Combinatorial search for Hydrogen Storage Materials

(task leader Bernard Dam, VU)

- Determination of sorption properties and thermodynamics by **Hydrogenography**
- preparation of thin films with a **composition gradient**
- Comparison with bulk material properties
- Investigation of **surface coatings** \Rightarrow catalysts, barriers

System integration of selected Hydrogen Storage Materials

(task leader Nico Eigen, GKSS)

- **Cost-effective preparation methods** for technically relevant complex hydrides like e.g. NaAlH_4 and **Up-scaling up to kg scale**
- Investigation of **hydride behaviour on a technical scale** and determination of **technically relevant materials parameters**