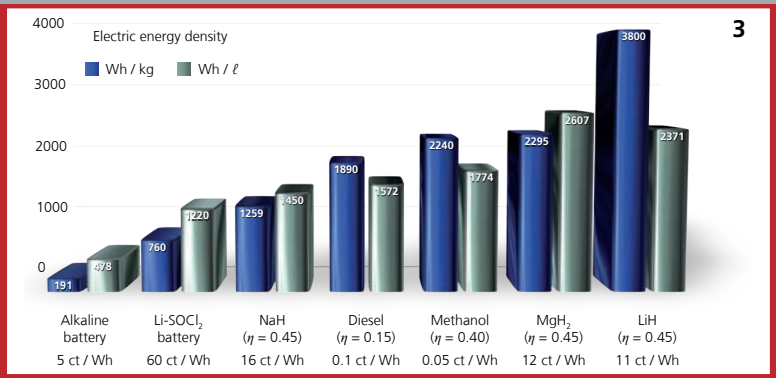
Fraunhofer
IFAM

FRAUNHOFER INSTITUTE FOR MANUFACTURING TECHNOLOGY
AND ADVANCED MATERIALS IFAM, BRANCH LAB DRESDEN


1


2



1 *Metal hydride powders and surface activation through ball milling*
2 *Lab-scale testing of different catalysts*
3 *Electric energy densities and costs of various storage materials*

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM Branch Lab Dresden

Winterbergstrasse 28
01277 Dresden | Germany

Contact

Dr. rer. nat. Lars Röntzsch
Phone: +49 351 2537 411
E-mail: Lars.Roentzsch
@ifam-dd.fraunhofer.de

Dr. rer. nat. Marcus Tegel
Phone: +49 351 2537 413
E-mail: Marcus.Tegel
@ifam-dd.fraunhofer.de

Fax: +49 351 2537 399

www.h2materials.de
www.ifam-dd.fraunhofer.de

HYDROGEN GENERATION VIA HYDROLYSIS OF METAL HYDRIDES

Hydrolysis of Metal Hydrides

Hydrogen is an environmentally friendly energy carrier with a very high gravimetric energy density. Its chemical energy can be readily converted to electrical energy by means of fuel cells. However, direct storage of pressurized H_2 is difficult as it involves expensive, heavy and bulky tanks as well as safety fittings, which goes far beyond the requirements for many portable applications. In low power applications especially, diffusion losses limit the direct storage of hydrogen.

Metal hydrides as lightweight, compact, non-volatile, safe and reasonably priced compounds overcome these issues. In combination with water they can thus serve as energy sources similar to conventional or special batteries (e.g. Li-$SOCl_2$) but with a gravimetric and volumetric energy density at least one order of magnitude higher.

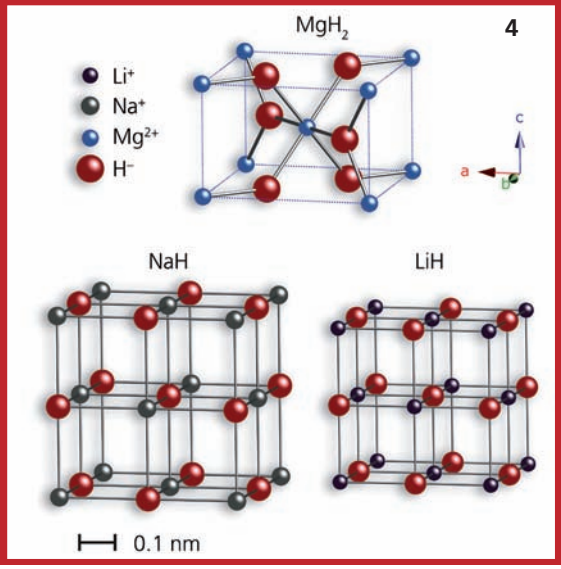
Applications

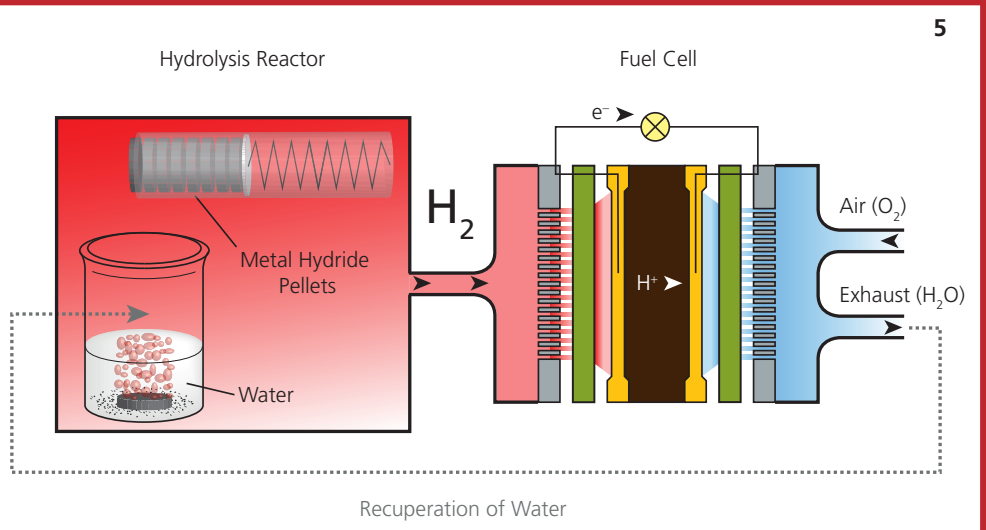
- backup / emergency power supplies
- standalone radiocommunication
- beacons
- sensors
- probes

Properties of Lightweight Metal Hydrides

- NaH
  - gravimetric H_2 density of 8.4 %*)
  - electric energy density 1259 Wh/kg*)
  - very fast hydrolysis kinetics
- MgH_2
  - gravimetric H_2 density 15.3 %*)
  - electric energy density 2295 Wh/kg*)
  - slow hydrolysis kinetics
- LiH
  - gravimetric H_2 density 25.4 %*)
  - electric energy density 3800 Wh/kg*)
  - fast hydrolysis kinetics

*) under the assumption that H_2O is recuperated / available in excess





Hydrolysis Reactions

$MeH + H_2O \longrightarrow H_2 + MeOH$

In hydrolysis reactions both the total amount of released hydrogen and the reaction kinetics strongly depend on a number of factors:

- type of hydride
- active surface area
- pH
- presence of buffers
- salinity of water
- water temperature

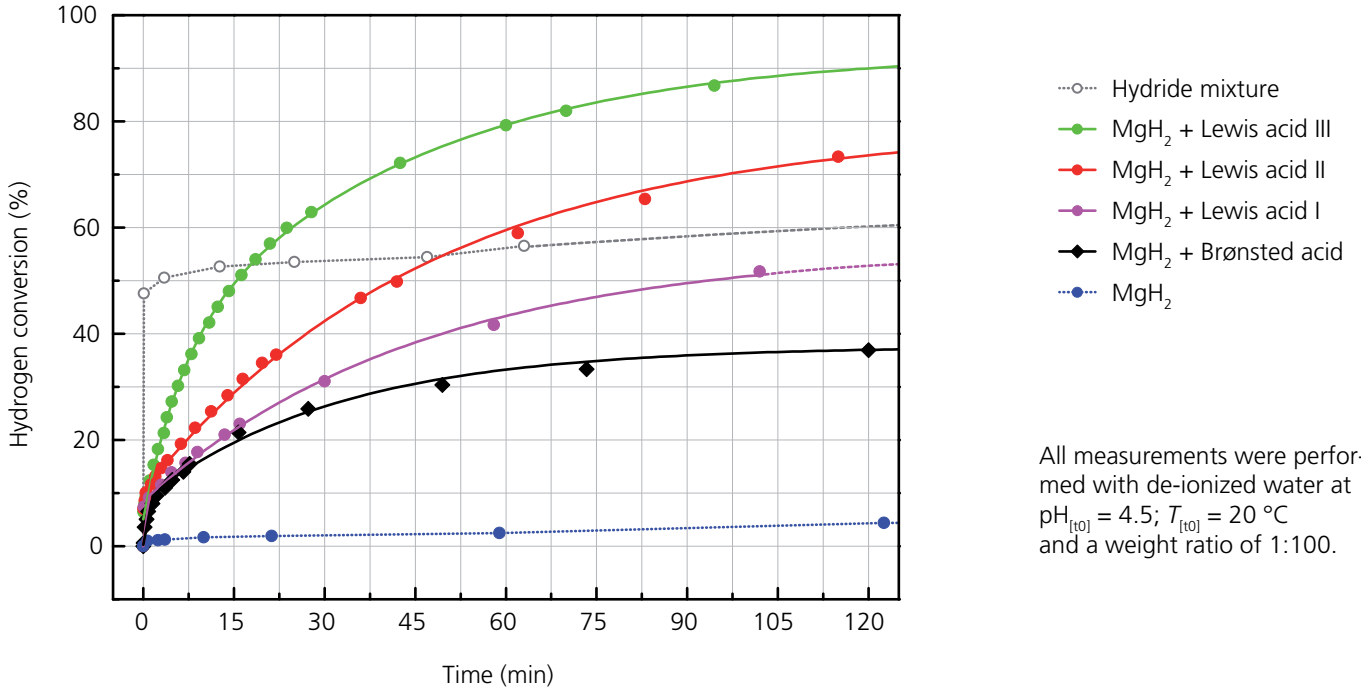
Beyond that the reaction is catalyzed by the addition of certain Lewis acids. Therefore, an optimization of hydrolysis reactions is feasible for a wide range of different applications.

Fraunhofer R&D Services

- Development of storage materials with regard to specific requirements, e.g.
  - suitable kinetics
  - high energy density
  - environment-related aspects
- Development of materials processing technologies
- Specialized water treatment (e.g. for sea water applications)
- Construction, test and evaluation of metal hydride cartridges suitable for hydrolysis
- Safety and reliability tests
- System development and testing
- System integration with fuel cells
- Software development

4 Crystal structures and proportions of different metal hydrides

5 Outline of a hydrolysis reactor in combination with a fuel cell



All measurements were performed with de-ionized water at $pH_{[t0]} = 4.5$; $T_{[t0]} = 20$ °C and a weight ratio of 1:100.

Fig. 1 Time-dependent hydrogen generation for mixtures of commercially available MgH_2 and activated MgH_2 with various solid catalysts