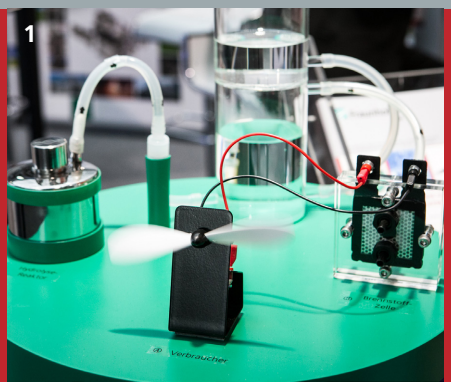
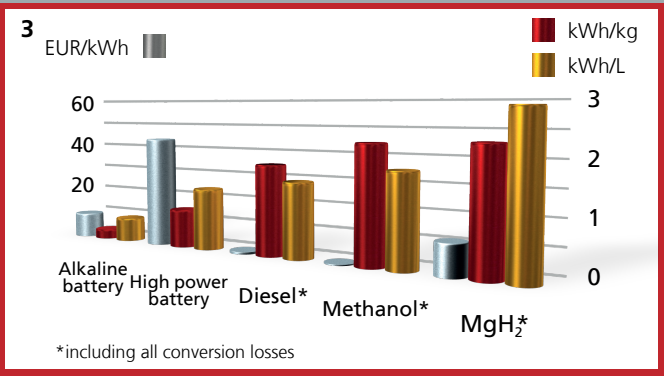
Fraunhofer
IFAM

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





1 *Hydrolysis demonstrator*
2 *Hydrolysis reaction of a MgH_2 pellet*
3 *Electrical energy densities and costs of high energy storage materials*

HYDROLYSIS OF MgH_2 FOR ULTRA HIGH ENERGY APPLICATIONS

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

Winterbergstrasse 28
01277 Dresden | Germany

Contact

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

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

www.ifam.fraunhofer.de/h2

Key Facts

The hydrolysis reaction of MgH_2 with water is a very promising way to generate hydrogen for ultra high energy fuel cell applications. Through MgH_2 hydrolysis, hydrogen storage capacities of up to 15.3 wt.-% are possible, if water is available on-site. In combination with fuel cells, material specific electrical energy densities as high as **2.3 kWh/kg** and **2.9 kWh/liter** can be achieved - including all conversion losses. This makes the gravimetric energy density twelve times higher than in conventional single-use alkaline batteries.

Thus, compact, safe and inexpensive energy sources with a nearly unlimited shelf life can be built. The invention of highly efficient and dynamic MgH_2-based hydrolysis fuels by Fraunhofer IFAM Dresden, their production and hydrolysis systems are patent pending, **the invention was awarded with the 2013 f-cell award** (1st place, category "Science").

Applications

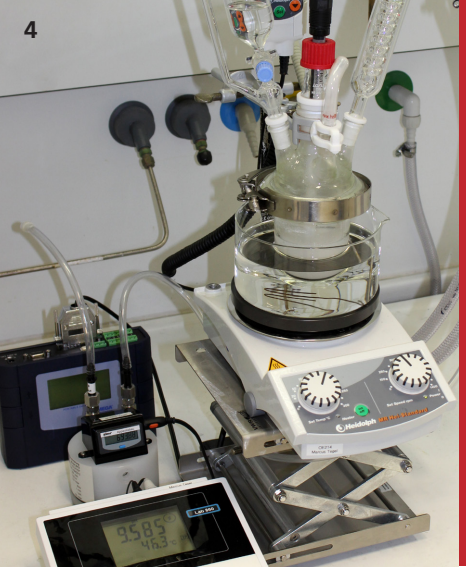
- Backup- and emergency power
- Electric drives / range extenders
- Portable electronic devices and chargers
- Emergency rescue / response systems
- Marine power generators
- Camping and outdoor equipment
- Sensors and probes
- Beacons, light signals

Advantages of MgH_2 Hydrolysis Reactions

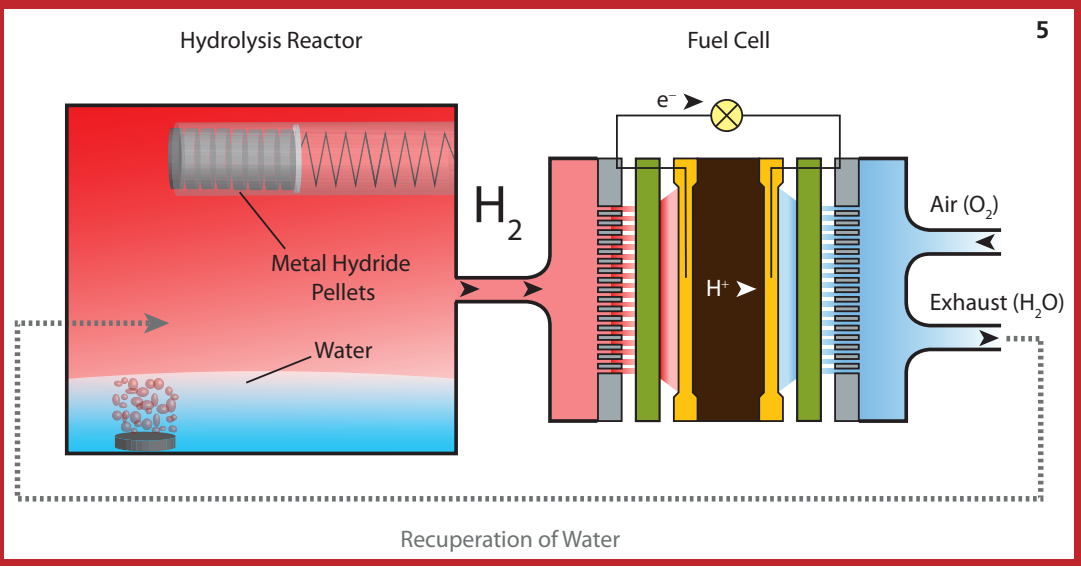
MgH_2 as hydrogen storage material for hydrolysis reactions has a variety of advantages over other high energy materials:

- Ultra high energy densities
- Long shelf life (no self-discharge)
- Non-toxicity of all materials
- Ease of material handling and high safety
- No special fuel cells, no reformers
- Noiseless and zero emission
- Operation temperature: < 0 °C to 80 °C
- Power range: 1 W to ~ 5000 W

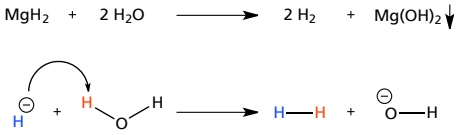
4



5



Detailed Information



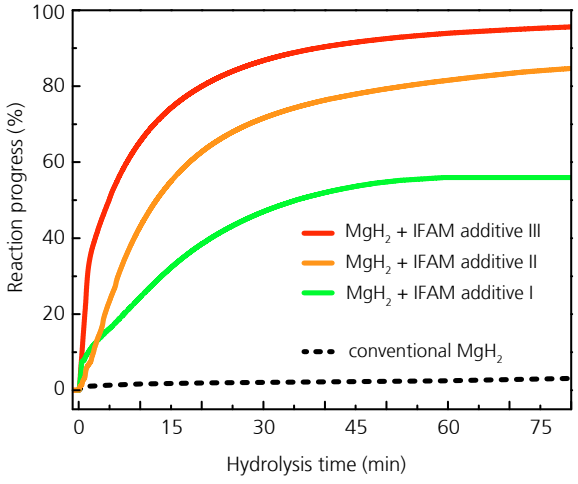
When MgH_2 is hydrolyzed, half of the generated hydrogen comes from the water, which is one reason for its ultra-high energy capacity. However, normally, the reaction is very slow due to passivation. At Fraunhofer IFAM, special MgH_2-based fuels (solids and pastes) with optimal reaction characteristics have been developed. Our MgH_2-based solids are favorable, if highest energy densities are needed, while our special patent-pending MgH_2-based pastes are advantageous, if maximum ease of use, high reaction control as well as highest reaction speeds and power densities are required.

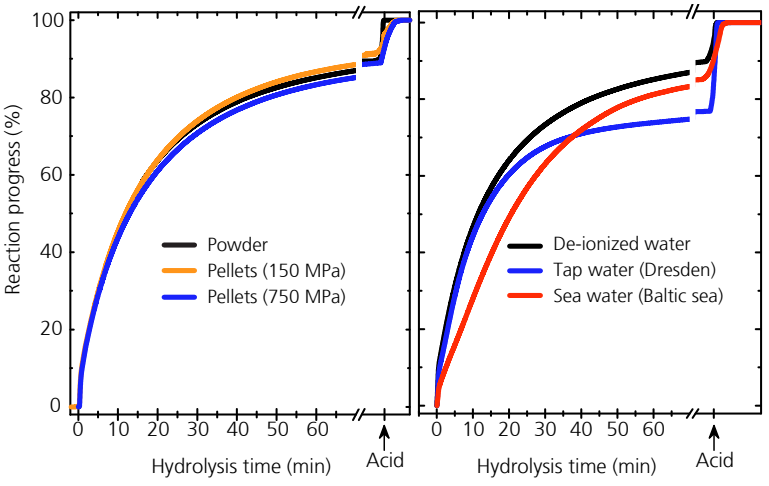
Fraunhofer R&D Services

- Optimization of hydrolysis fuels with regard to specific requirements, e.g.
  - Usable temperature range
  - Maximum shelf life
  - Reactivity (i.e. power density)
- Construction and evaluation of hydrolysis cartridges and hydrogen generators
- System integration with fuel cells (construction of power generators)
- System development and testing
- Safety and reliability tests
- Development of materials processing technologies
- Up-scaling
- Market analyses

4 *Lab-scale test rig for hydrolysis fuels*

5 *Outline of a hydrolysis system (Sketch)*





Left: Time-dependent hydrogen generation for conventional and IFAM-developed solid MgH_2 fuels.

Middle: Hydrogen development of powder and compacted material (with an increased volumetric density). Right: Test of water quality influence.