PURPOSE

Task 32 addresses hydrogen-based energy storage by developing reversible or regenerative hydrogen storage materials. The goals and objectives of Task 32 are:

- Develop reversible or regenerative hydrogen storage materials fulfilling the technical targets for mobile and stationary applications.
- Develop the fundamental and engineering understanding of hydrogen storage materials and systems that have the capacity to fulfill Objective 1.
- Develop materials and systems for hydrogen-based energy storage, including hydrogen storage for use in stationary, mobile and portable applications, and electrochemical storage.

STATUS OF THE TECHNOLOGY

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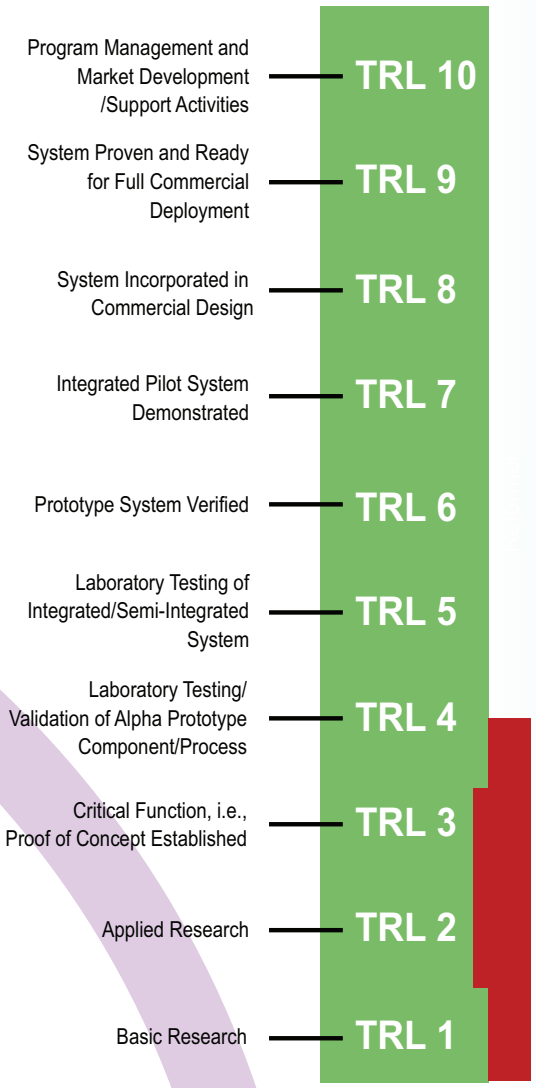
During the last 10–15 years, hydrogen has gained importance as an energy carrier. Hydrogen storage is a crucial step for providing a supply of hydrogen fuel to an end user, such as hydrogen used in vehicles, for portable devices and energy storage in general for stationary applications. Without effective storage systems, a hydrogen economy will be difficult to achieve. At present, compressed hydrogen with a pressure of up to 700 bar seems to be the choice of car manufactures, but there are still concerns related to both safety and cost. Hydrogen storage as liquid hydrogen at 20 K involves a number of challenges and is not considered for most applications. Hydrogen storage in solid materials or as liquid hydrogen carriers constitute alternatives which possess the potential to surpass the storage densities of compressed hydrogen. In particular, the high volumetric density, storage at low pressures that can be close to ambient conditions, and significantly improved safety are important driving forces for further strong research activities on hydrogen storage in solid compounds. Besides possible applications in vehicles,



TASK 32

HYDROGEN-BASED ENERGY STORAGE

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Operating Agent for Germany

VITAL STATISTICS

Term

2013-2015

Members

Australia
China
Denmark
France
Germany
Greece
Israel
Italy
Japan
Lithuania
Netherlands
Norway
South Korea
Sweden
Switzerland
United Kingdom
USA

Expert Participants

52

2014/15 Meetings

July 25–26, 2014
Manchester, UK
January 18–22, 2015
Chamonix, France

worldwide activities increased significantly for hydrogen used as energy storage, owing to the change from fossil fuel to "green" energy sources as wind and solar power. For these stationary applications, hydrogen storage in solid compounds is a very attractive concept. Furthermore, metal hydrides are important constituents in metal hydride batteries and also possible as electrolytes in Li-ion batteries.

TECHNOLOGY READINESS LEVEL (TRL)

The projects in Task 32 cover TRL 1 to TRL 4: Basic research, Applied research, Critical Function, i.e. Proof of Concept Established, and Laboratory Testing/Validation of Alpha Prototype Component/Process, respectively. The majority of the activities may be classified at TRL 2 and TRL 3.

FRAMEWORK SUMMARY

Task 32 began a three-year term in January 2013. The task is open to project types involving experimental, engineering, and modeling (both scientific and engineering) activities and is focusing on the following classes of materials:

- Reversible metal hydrides, including borohydrides, alanates, amides/imides-systems, magnesium-based compounds and reactive hydride composites
- Regenerative hydrogen storage materials (chemical hydrides)
- Nanoporous materials, including coordination polymer framework compounds (MOFs, ZIFs, COFs, etc.) and carbon-based compounds
- Rechargeable liquids hydrogen carriers
- Hydrogen-based compounds for electrochemical storage, e.g. MH-batteries, ion-conduction

Six working groups have been formed:

- Porous materials (coordination polymer framework compounds, MOFs, ZIFs, COFs and carbon-based compounds) (M. Hirscher, Germany)
- Magnesium-based hydrogen and energy storage materials (V. Yartis, Norway)
- Complex and liquid hydrides (borohydrides, alanates, amides/imides-systems, magnesium-based compounds, reactive hydride composites and rechargeable liquid hydrogen carriers) (A. Züttel, Switzerland)
- Electrochemical storage of energy (MH-batteries, ion-conduction) (M. Latroche, France)
- Heat storage – concentrated solar thermal using metal hydrides (C. Buckley, Australia)
- Hydrogen storage systems for mobile applications (B. van Hassel, USA)

MEMBERS

Fifty-two (52) experts from 17 countries are participating in Task 32 with a total effort of 55 person-years/year in 2014. A similar level of participation is expected for next year; additionally, Belgium will join with one expert.

ACTIVITIES AND RESULTS IN 2014

PROGRESS AND ACCOMPLISHMENTS

Two Task 32 Expert meetings were held in 2014/15:

After the MH2014 international Symposium a short meeting was held for Task 32 in Manchester, July 25–26, 2014 and had 39 participants from 17 countries (Figure 1).

A long Task 32 meeting is planned for January 18–22, 2015 in Chamonix, France.

During both meetings, the newest results were presented and discussed. After discussions in the working groups, the results were presented to all experts for a joint discussion. The group started preparing manuscripts which will be published in a special issue in Applied Physics A in 2015. Task 32 is the major forum for international activities in this field, and a number of international collaborative efforts have been established via active participation in the meetings.

OUTREACH AND COMMUNICATION

During the first year of Task 32, over 150 articles have been published in international peer-review journals. The experts presented results on numerous national and international meetings/conferences, e.g. three plenary and 17 invited talks have been held by Task 32 experts at the MH2014 International Symposium on Metal-Hydrogen Systems held in Manchester, UK, July 20–25, 2014. Task 32 was presented in a plenary lecture at the EHEC 2014 in Seville, Spain in March 2014.

FUTURE WORK

ACTIVITIES AND /OR TARGETS FOR 2015

A task meeting will be held in Massachusetts, USA in July 2015 in connection with the GRC on Hydrogen-Metal Systems, where the manuscript for the special issue will be discussed. The final submission is planned for July 2015. Additionally, a proposal for an extension of Task 32 will be prepared by the experts.

ACTIVITIES AND/OR TARGETS BEYOND 2015

Two task meetings are planned for 2016, the first in Japan in Spring 2016, and the second (the short meeting) in August 2016 after the MH2016 in Interlaken, Switzerland.

R&D CHALLENGES

Energy storage will be key to the change from a fossil-based to a renewable energy-based economy. Storage of hydrogen remains one of the major challenges for both mobile and stationary applications. For mobile applications in particular, at present, solid materials do not fulfill all requirements with respect to weight and volume of storage systems, conditions (temperature and pressure) for hydrogen storage and kinetics of the hydrogen uptake and release. Use of solid storage for stationary storage appears to be more feasible in the shorter term, but materials still need optimization. The fundamental understanding of hydrogen storage mechanisms is the key for a breakthrough in the development of

materials with improved properties. For technical applications, a combined understanding of both fundamental and engineering aspects will be important. Additionally, improved hydrogen-based energy storage for either heat or electro-chemical storage will be a future target.

Figure 1 Participants at the Task 32 meeting in Manchester, UK, July 25–26, 2014.