Hydrogen + Fuel Cells 2011
partnerships for global energy solutions
International Conference + Exhibition
Vancouver, British Columbia, Canada
Vancouver Convention + Exhibition Centre
May 15 – 18, 2011

Novel Hydrogen Storage Solutions for Space and Aerospace

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fotec research + technology

The Space Propulsion & Advanced Concepts group has changed its owner:

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY → FH Wiener Neustadt + fotec research + technology

- All R&D projects are transferred to FOTEC GmbH which is 100% owned by the University of Applied Science, Wiener Neustadt (~45km south of Vienna)
- We have now the direct access to the university and the core competences of fotec (rapid prototyping, innovative software systems, measurement technology).
- The building of the “Aerospace Engineering” program at the University of applied sciences offers also a cross linking between students, fotec and Austria's space and aerospace industries.

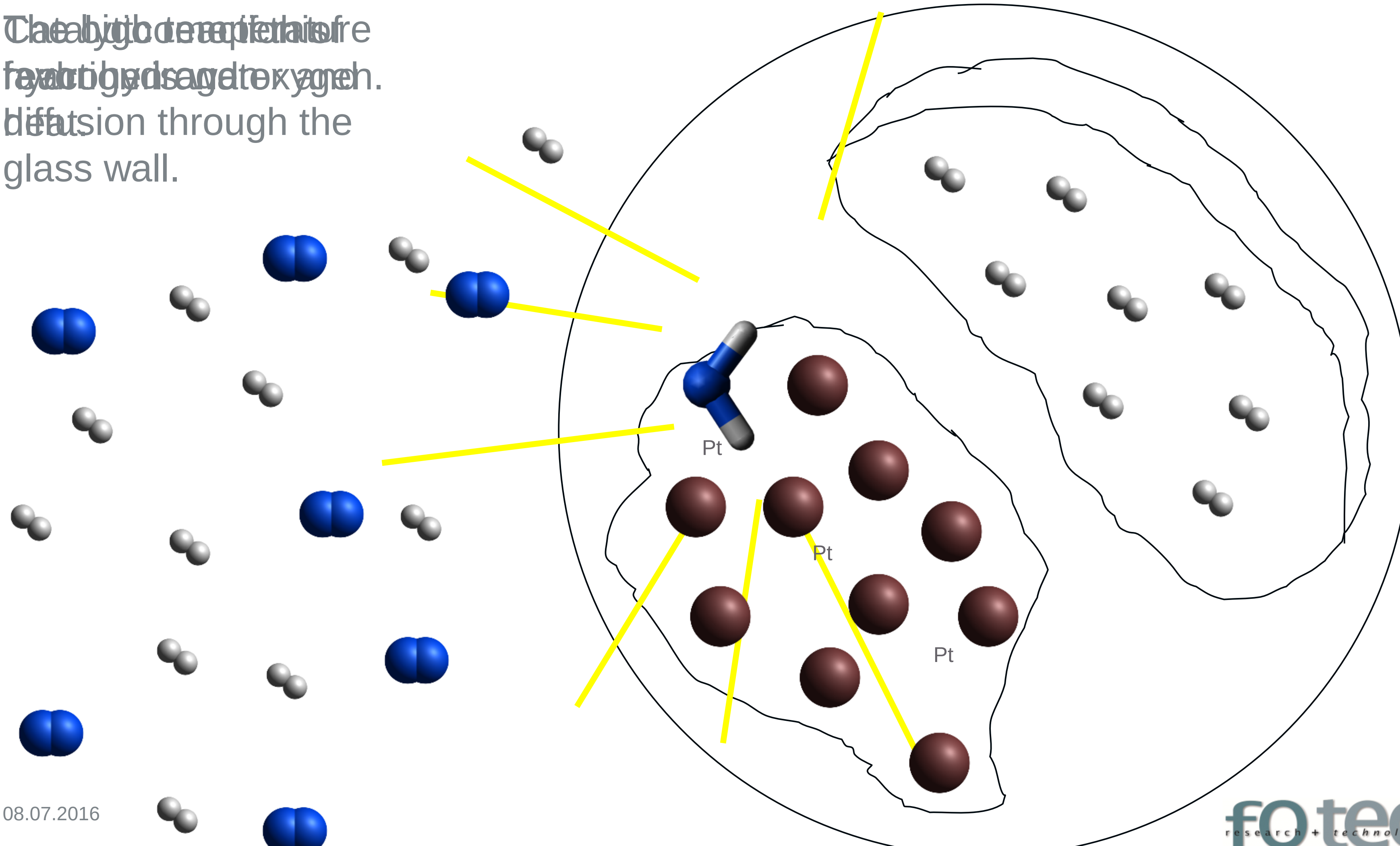
Hydrogen/Helium Storage using Hollow Glass-Microspheres

- **Project**: Development of a hydrogen/helium storage system based on high pressure gas storage inside hollow glass microspheres.
- **Problem:** Efficient gas release system is required.
- **Solution:**
  - » Chemical gas release process = higher efficiency, higher complexity (catalyzer coating, chemical reaction)
  - » Electrical gas release process = less efficiency, higher accuracy and less complexity

Microsphere - Chemical Gas Release Process

The high temperature facilitates hydrogen diffusion through the glass wall.

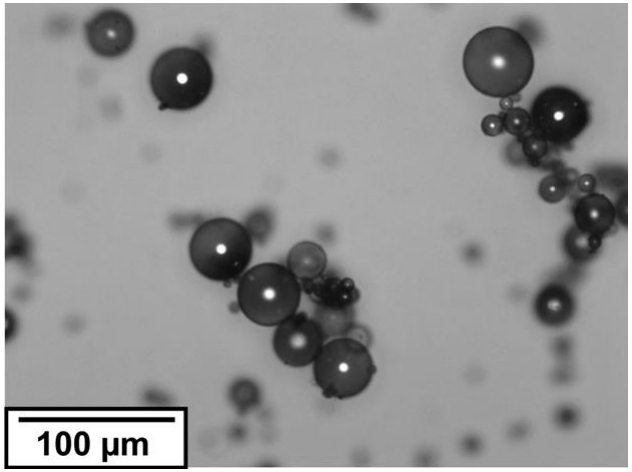
Catalytic combustion of hydrogen and oxygen heat.



Microsphere - Chemical Gas Release Process

- **Project:** Uniformly coating of microspheres by a magnetron sputtering process in cooperation with the Vienna University of Technology.

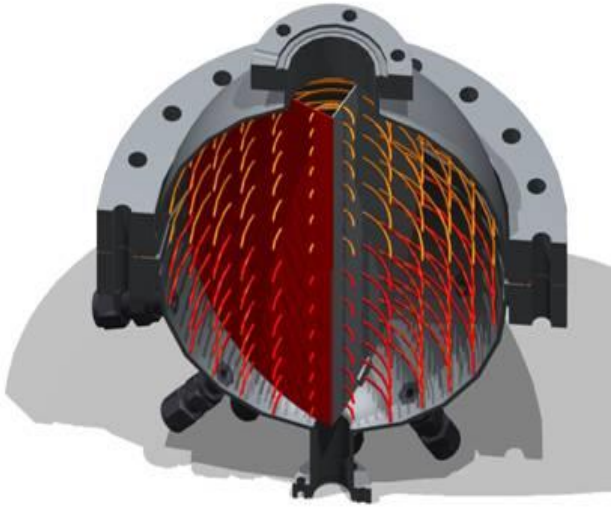
- **Project Description:**
  - Microspheres were successfully sputtered with copper and platinum.
  - The geometry of the vessel containing microspheres was carefully adjusted and optimized to avoid agglomeration and to achieve good intermixing behavior.
  - Next steps are the production of multilayered catalytic films and testing of them.



Pt – sputtered microspheres – *G. Schmid et al. / Surface & Coatings Technology 205 (2010) 1929 - 1936*

Microsphere - Electrical Gas Release Process

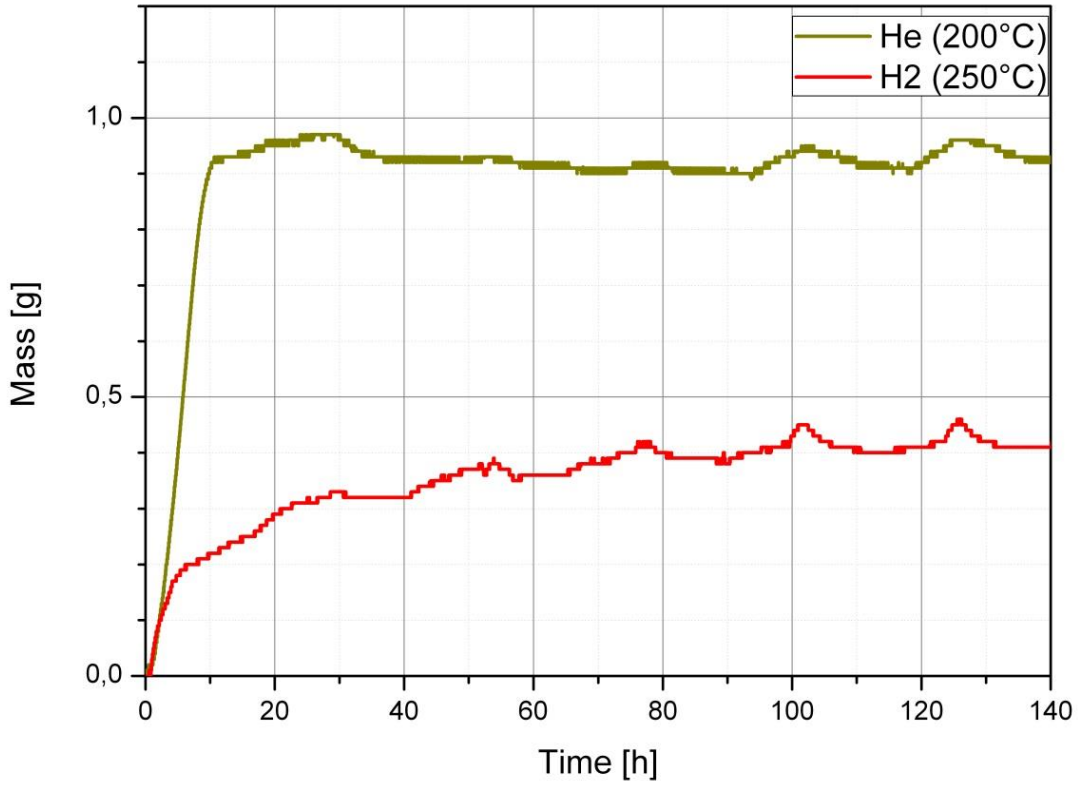
- **Project:** Development of an electrical controlled gas release system for hydrogen and helium. Replacement of high pressure helium tanks on satellites.
- **Project Description:**
  - The new gas generator reaction chamber design based on the experience of four years.
  - It has less external impact due to better isolation and smaller design.
  - Heating wire inside.
  - More precise measurement with 13 thermocouples.
  - Thermodynamic analysis with ANSYS™.



Gas Generator Reaction chamber. (150 mm Ø)

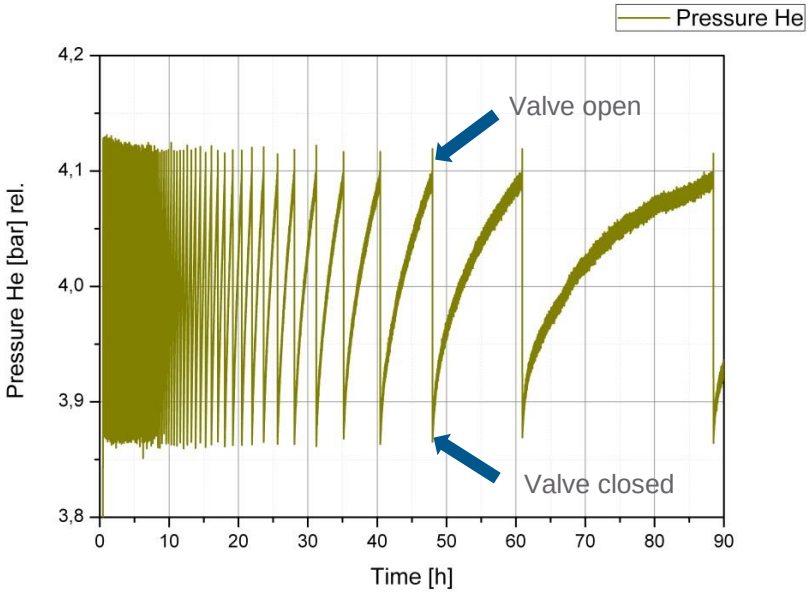
Microsphere - Electrical Gas Release Process

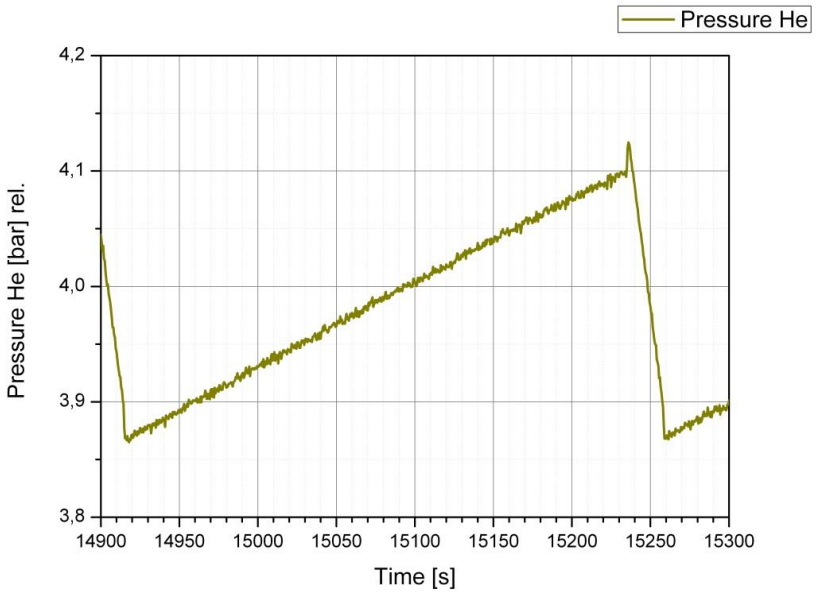
- Gas release tests for H_2 and He filled microspheres (50 bar) at different temperatures.



Helium Gas Release Test With Fotec's Gas Generator

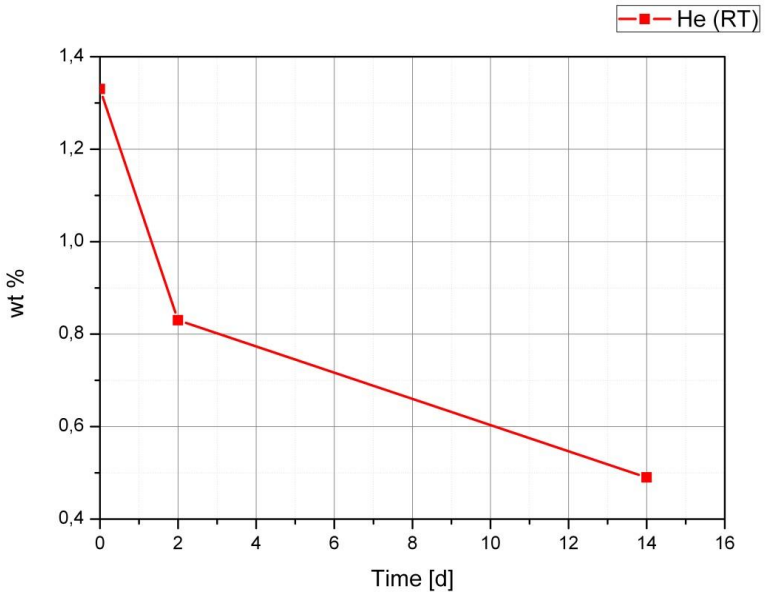
- 0.05 g helium were released during one cycle. The measured storage capacity was 2.3 wt.-% at 67 bar filling pressure. The maximum storage capacity is ~20 wt.-% (at 700 bar filling pressure).

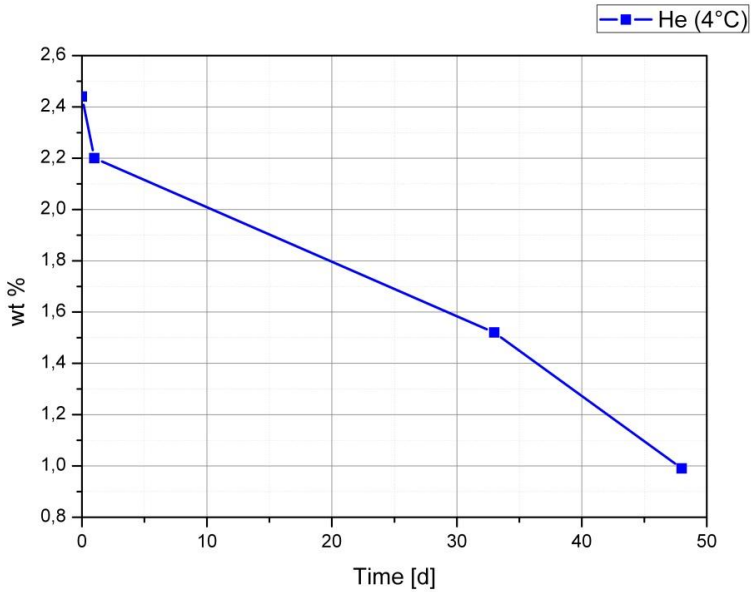




Helium Long-Term Storage Test

- Two batches of helium filled microspheres were tested at room temperature and at 4°C. The first batch was filled at 43 bar and lost half of the helium after 7 days and the second batch was filled at 118 bar and lost half of the helium after 42 days.

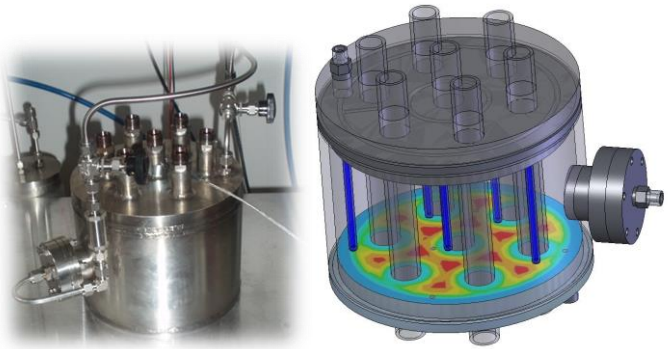




Metal Hydrides as Hydrogen and Heat Storage System

- **Project**: Development of a reversible hydrogen and heat storage system based on metal hydrides (Sodium Alanate) and direct integration of them into the reversible fuel cell system

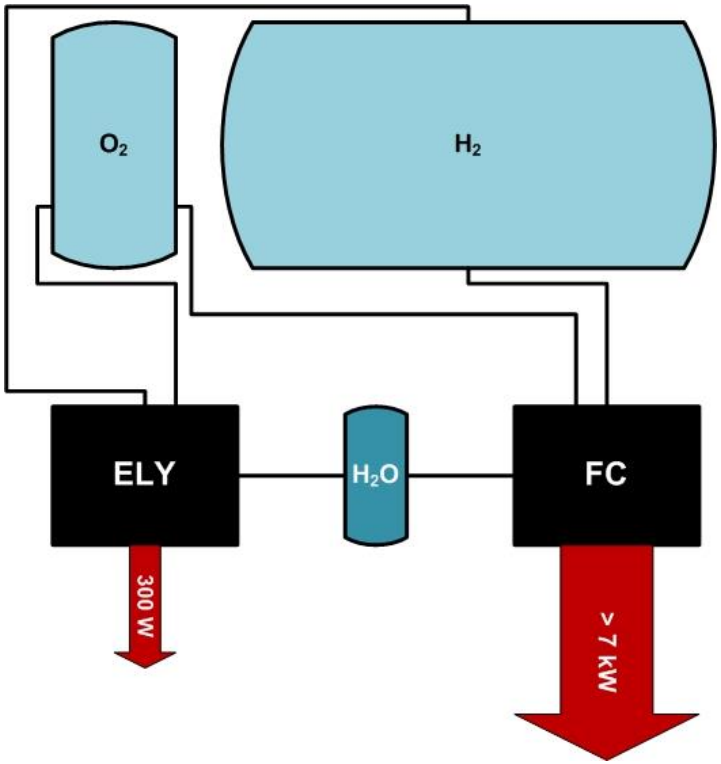
- **Project Description:**
  - Testing of a metal hydride ($NaAlH_4$) based reversible hydrogen storage system – finished – Our prototype stored 3.6 wt.-%



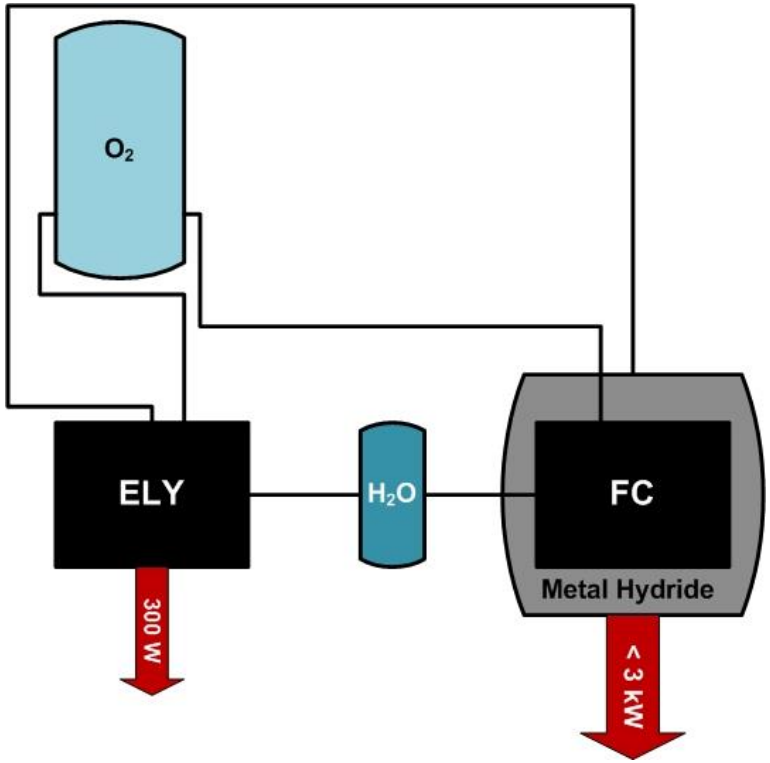
  - Preliminary calculations of the complete system efficiency – finished
  - Numerical simulation of the integration of a fuel cell directly into the metal hydride reservoir – in progress (optimum tank structure, thermal characteristics of MH's, optimum thermal coupling)
  - Design, manufacture and testing of a technology demonstrator – next year

New System Design Concept for Satellites

Classical RFCS

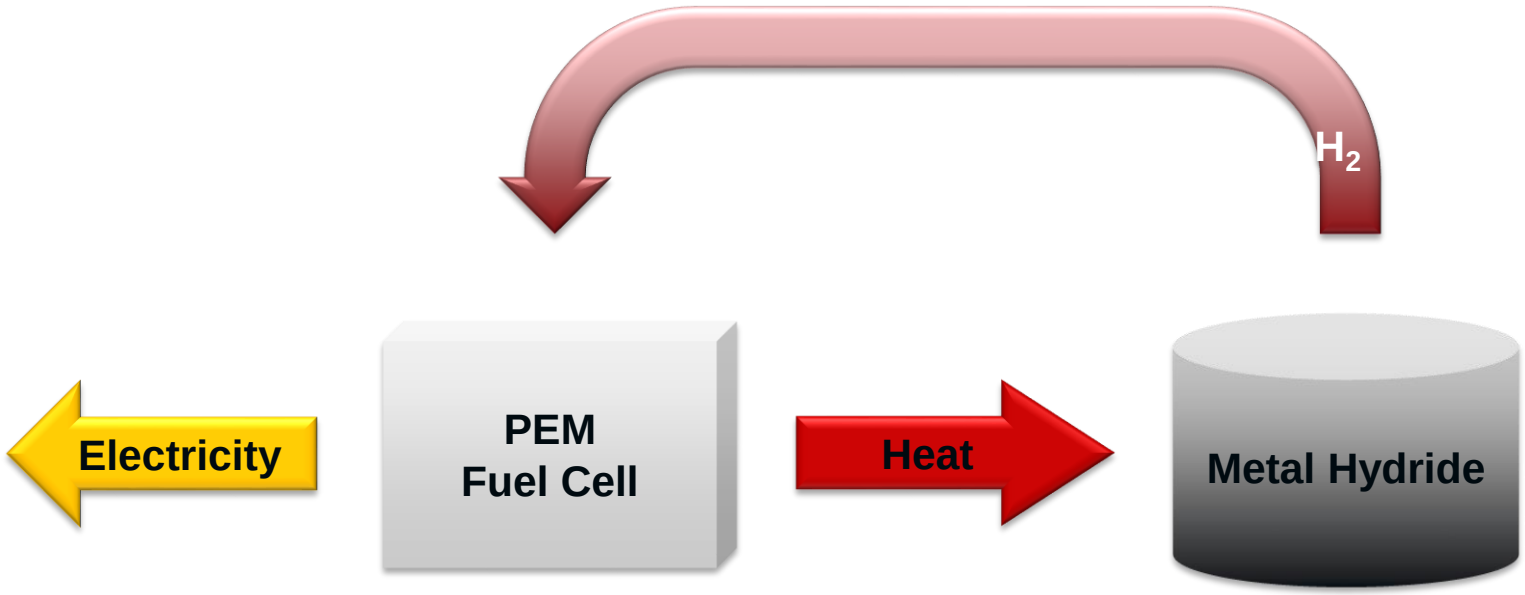


new MH-RFCS



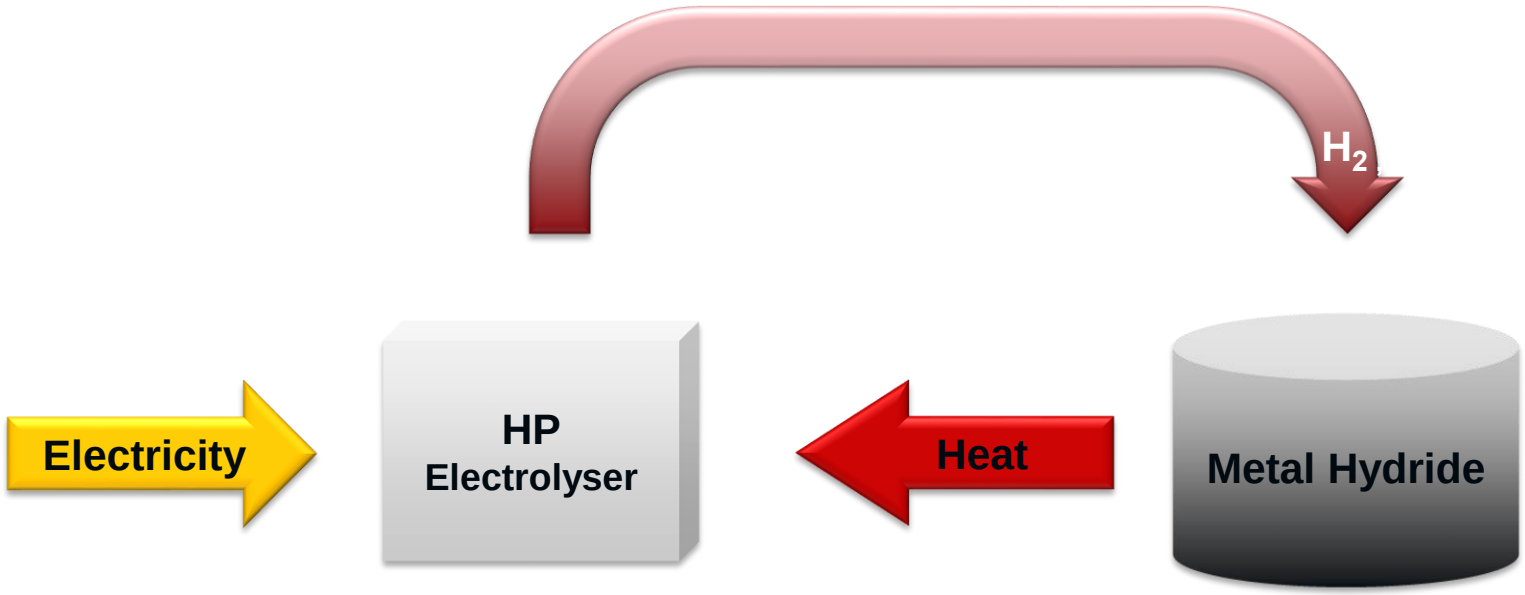
New System Design Concept

Heat Loss Recovery at Discharging

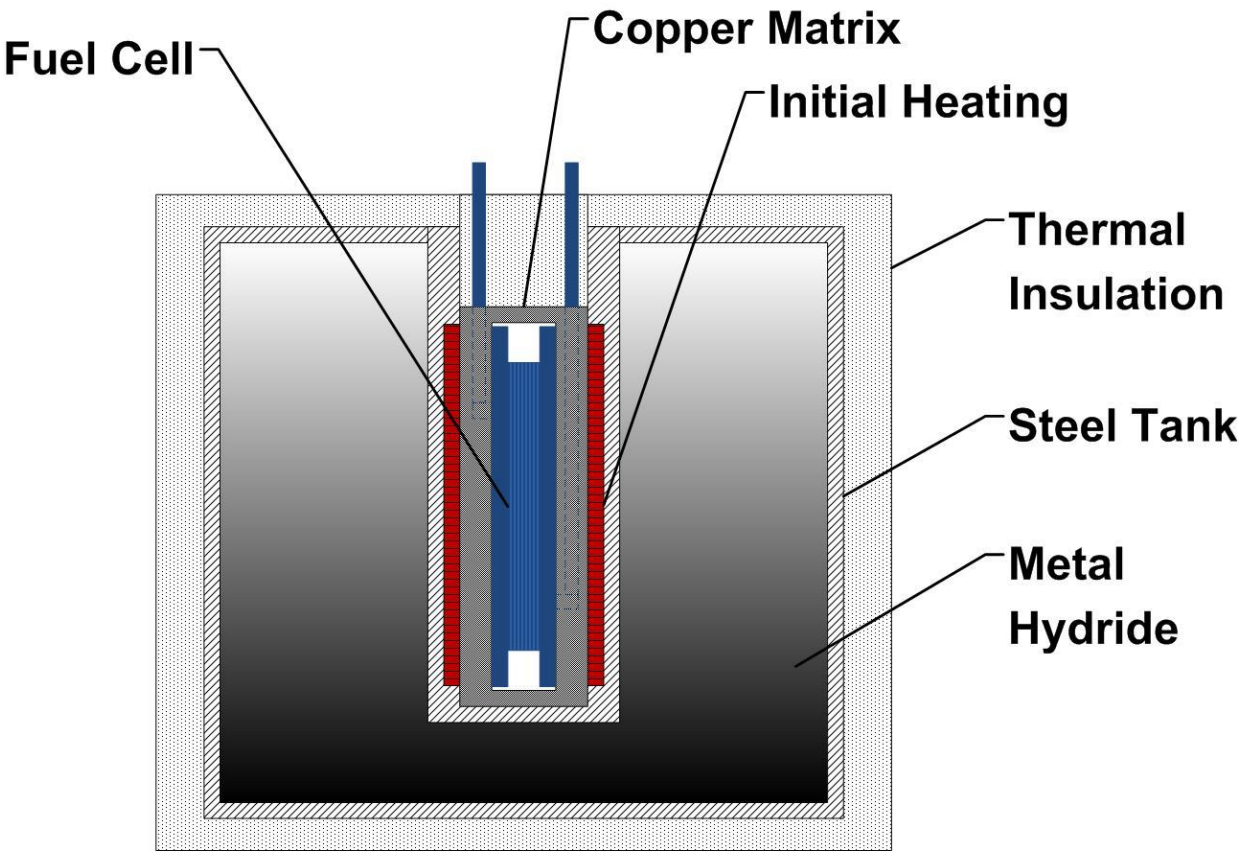


New System Design Concept

Heat Loss Recovery at Charging



Preliminary Design Concept



System Improvement Compared to RFCS with Pressurized H_2 Gas Tank and Li-Ion Battery

	G5 Li-Ion Batteries	RFCS with High Pressure Gas Storage	RFCS with Metal Hydride Gas Storage
Mass Budget for 11,3kW System	**178kg**	**115kg**	**~70kg**
for 21,5kW System	320kg	185kg	
Volume Requirement for 11,3kW System	**180L**	**100L**	**~80L**
for 21,5kW System	280L	200L	

Possible application for systems with challenging thermal management e.g. Satellites or Submarines

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Thank you for your attention! Questions?

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