SSH2S
(256653)
Fuel Cell Coupled Solid State Hydrogen Storage Tank

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SSH2S in figure

Beginning:
Feb. 1st, 2011

End:
Sept. 30th, 2014

Duration:
42 months

Budget:
3.5 M€ Total
1.6 M€ JU contribution

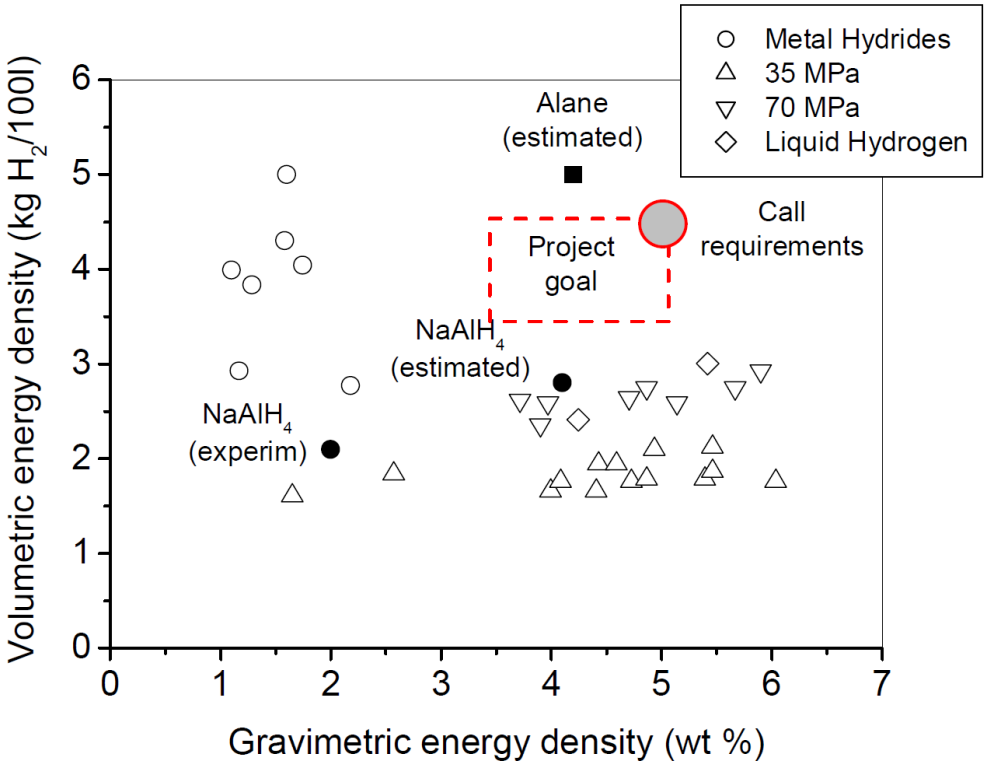
Partners:
4 research + JRC
3 industries

Beneficiary Number *	Beneficiary name	Beneficiary short name	Country
1. (Coordinator)	Università di Torino	UNITO	Italy
2.	Institute for Energy Technology	IFE	Norway
3.	Karlsruhe Institute of Technology	KIT	Germany
4.	Deutsches Zentrum für Luft- und Raumfahrt e.V.	DLR	Germany
5.	Tecnodelta s.r.l.	TD	Italy
6.	Serenergy A/S	SER	Denmark
7.	Centro Ricerche Fiat	CRF	Italy
8.	Joint Research Centre of European Commission	JRC	Belgium

SSH2S in picture

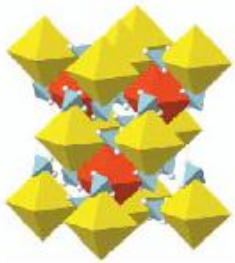
SSH2S goals

- ***Integration** between hydrogen storage system and HT-PEM fuel cell*
- ***Development of new materials** with high gravimetric and volumetric energy density*
- ***Technically relevant loading temperature and pressure***
- ***Loading time** and **stability** of performances after several cycles*
- ***New tank for supply of hydrogen flow.***
- ***Low cost***

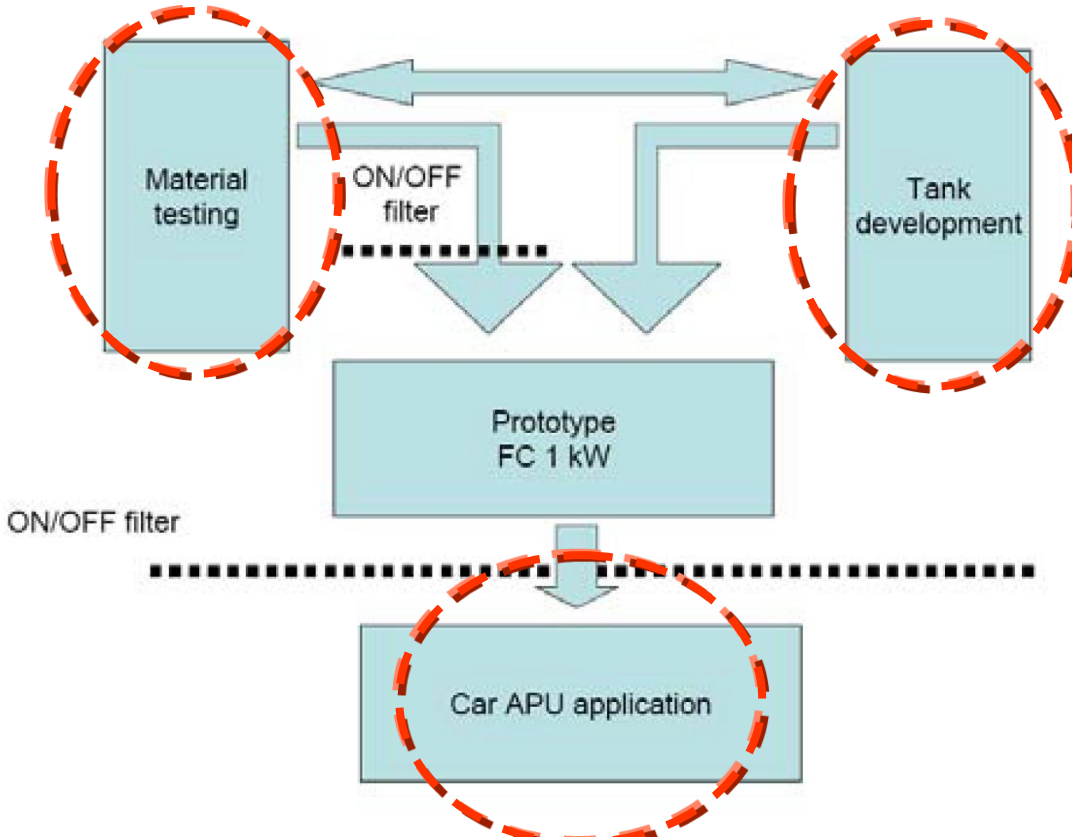


Volumetric and gravimetric energy density of hydrogen storage systems

SSH2S scheme



INNOVATION

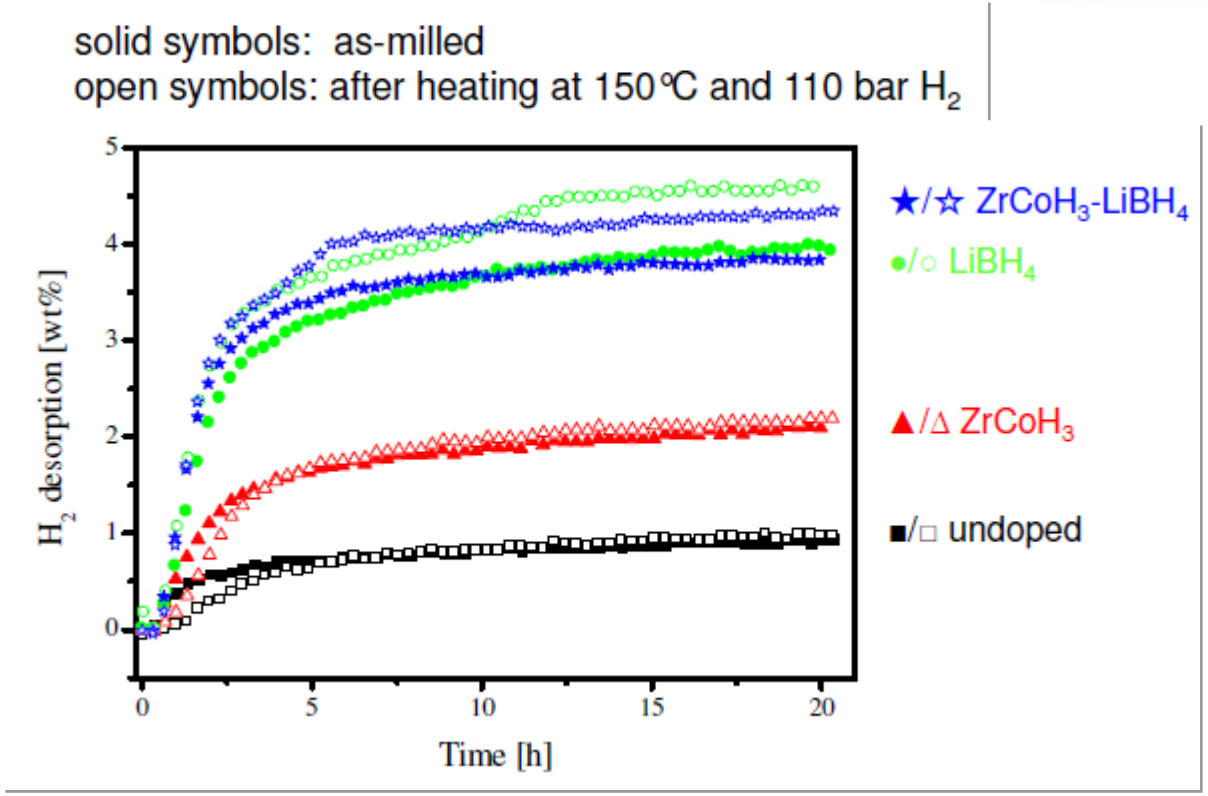


From new materials to integrated system.

5 kW_{el} APU

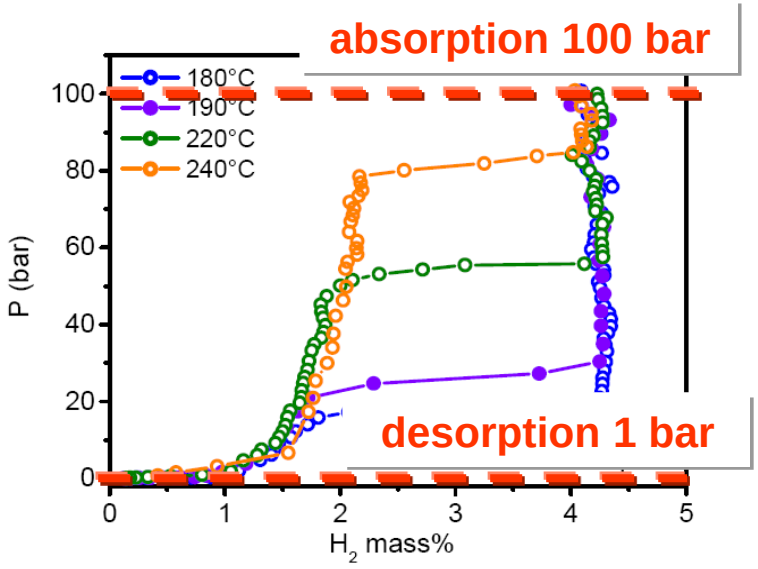
SSH2S results: material selection

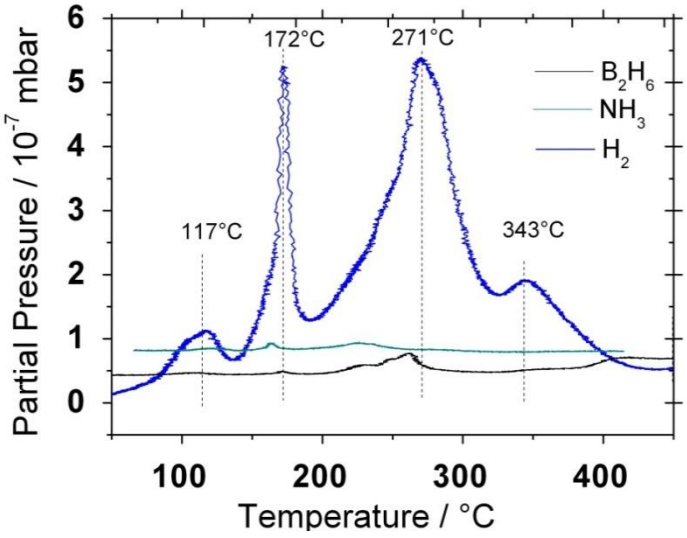
- *Material for prototype tank selected*
- *200 g $LiNH_2$-MgH_2 plus additives will be produced*
- *Basic characterization performed*
- *Up to 10 cycles stability*



Desorption isotherms at 150° C

SSH2S results: material selection





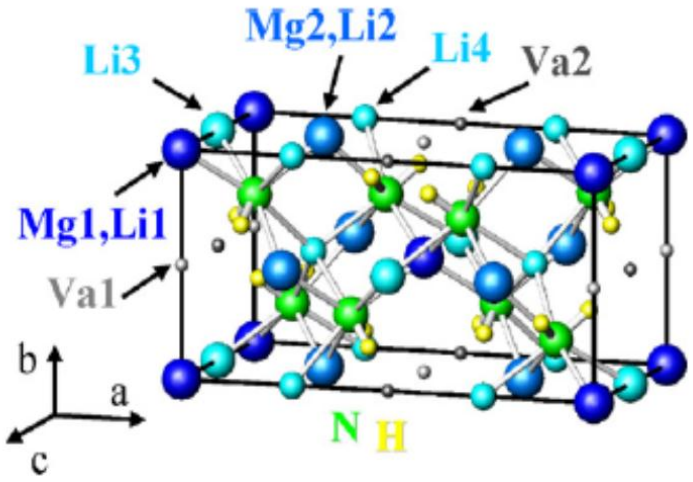
PCI measurement of hydrogen storage material

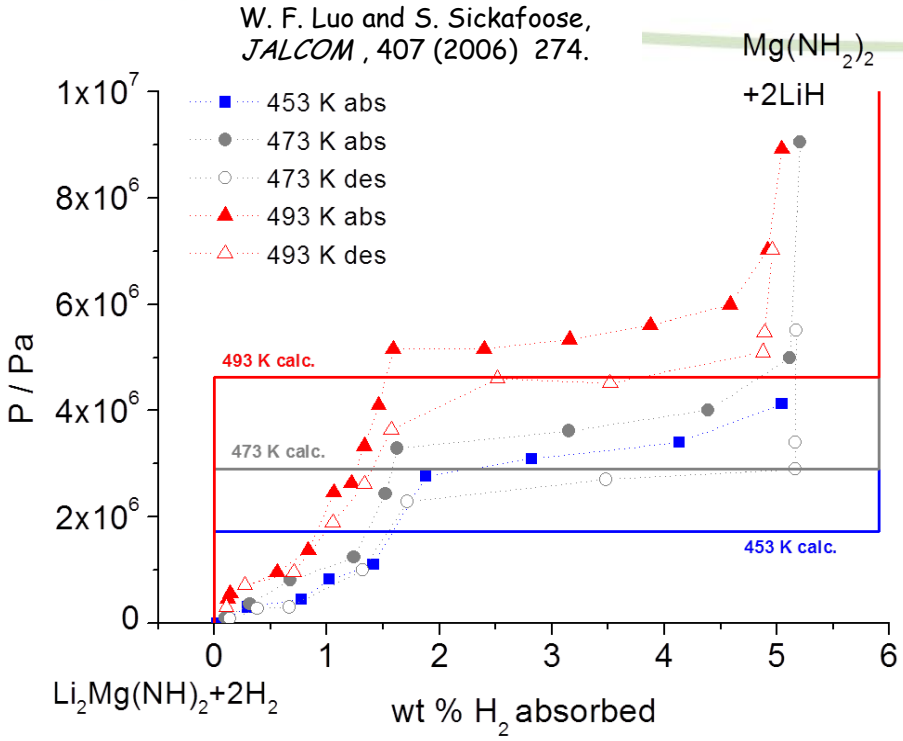
TPD of LiNH2-MgH2 system

- ***4.5 H2 wt% gravimetric density at 180 ° C***
- ***No pollution observed***

SSH2S results: material modelling

- ***PCI curves modeled by combination of ab-initio and Calphad methods***
- ***Evidence of solid solution for low absorption***



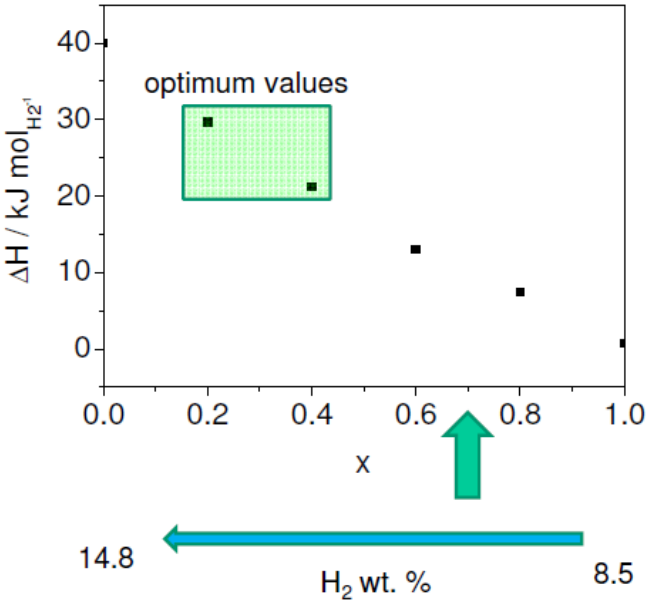


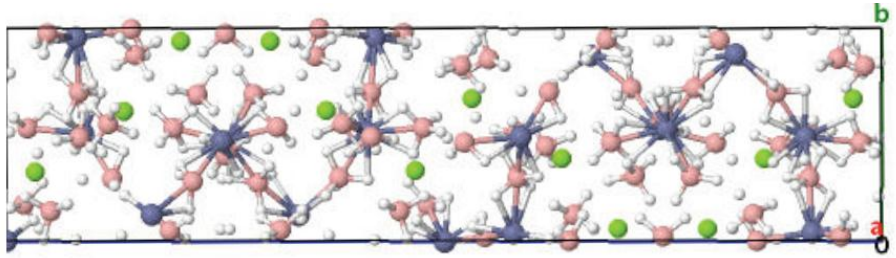
Modeled PCI curve for LiNH2-MgH2 system

T. Noritake, M. Aoki, M. Matsumoto, K. Miwa, S. Towata, H.-W. Li and S. Orimo, *JALCOM* 509 (2011) 7553.

SSH2S results: new material development

- *Ab-initio modeling of new materials*
- *Mg-0.7Zn mixed borohydride selected*
- *Na-TMF_3 (TM = Ti, Mn, Fe) systems investigated*



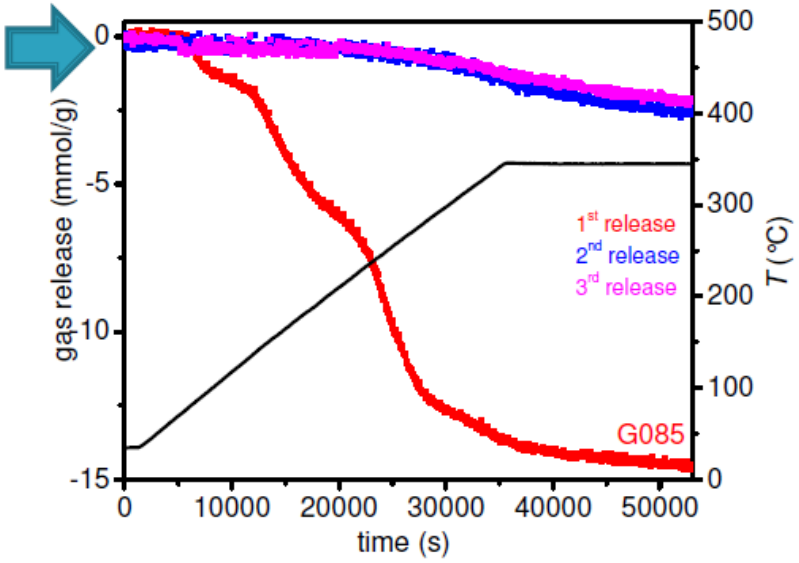


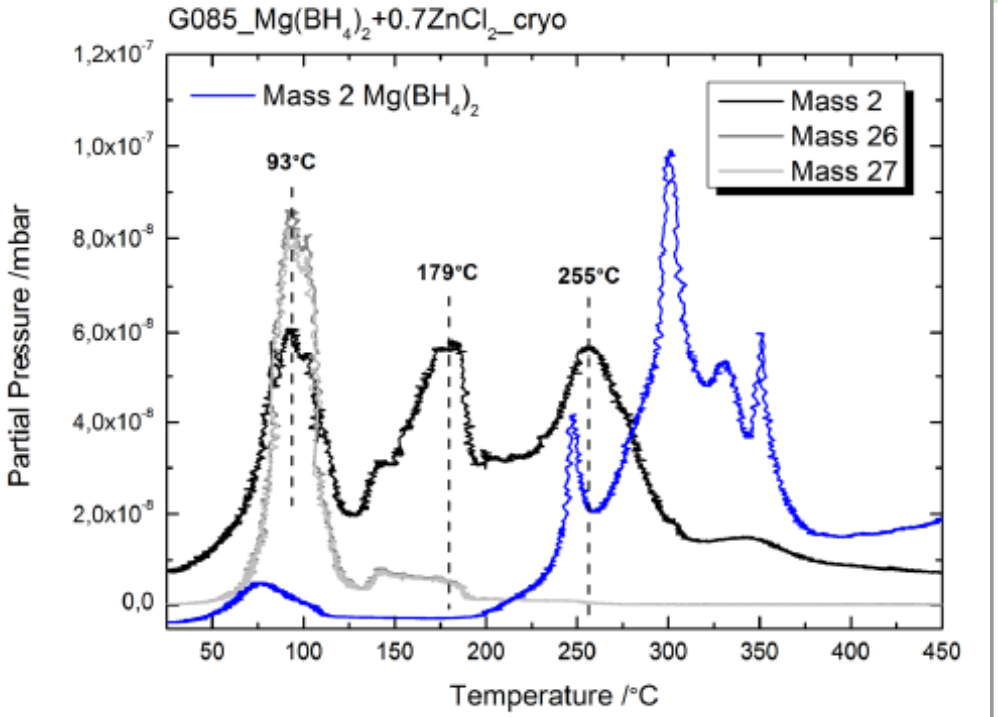
Ab-initio modeled structure of mixed borohydride

Effect of molar fractions of zinc (x) on decomposition enthalpy

SSH2S results: new material development

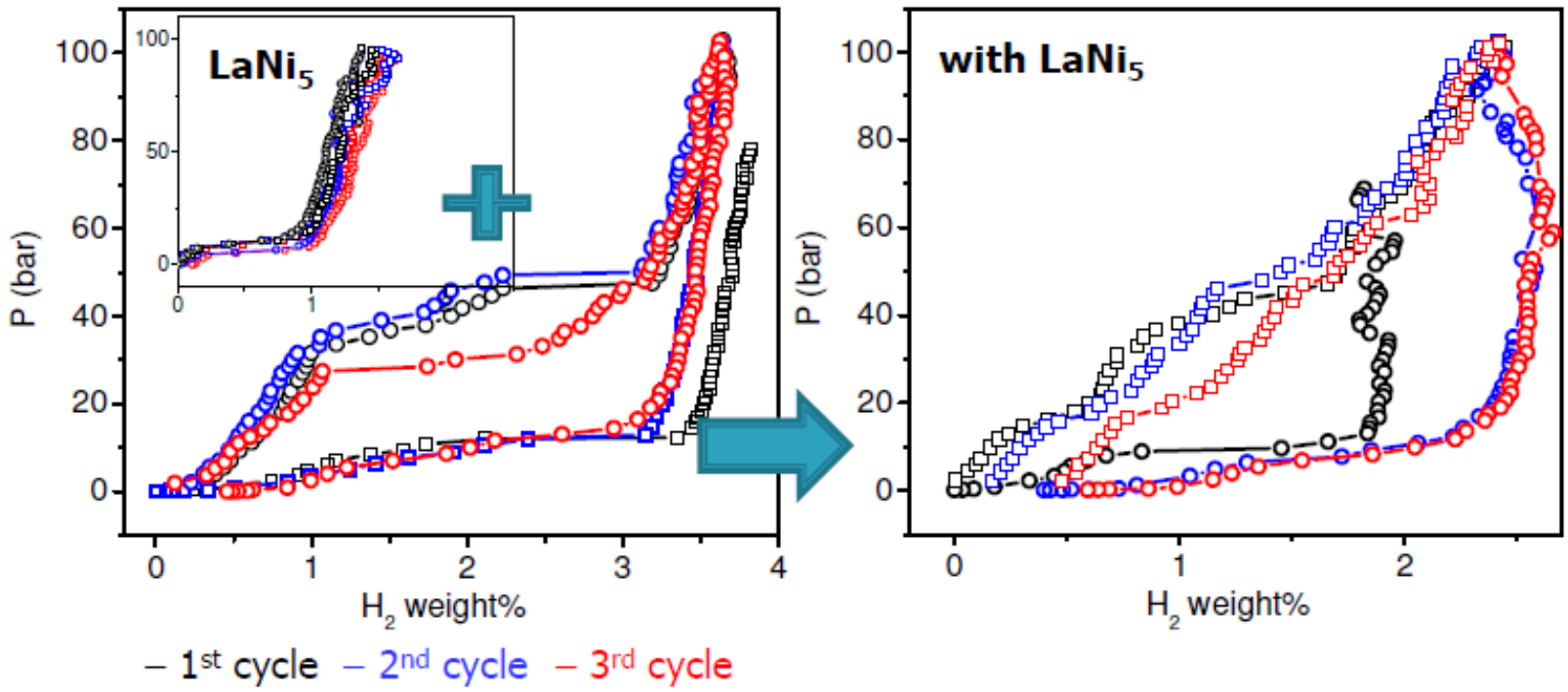
- *Basic characterization*
- *B2H6 release observed*
- *No reversibility observed*
- *ON/OFF decision: stop activites*





Gas release from mixed borohydride

SSH2S results: new concept

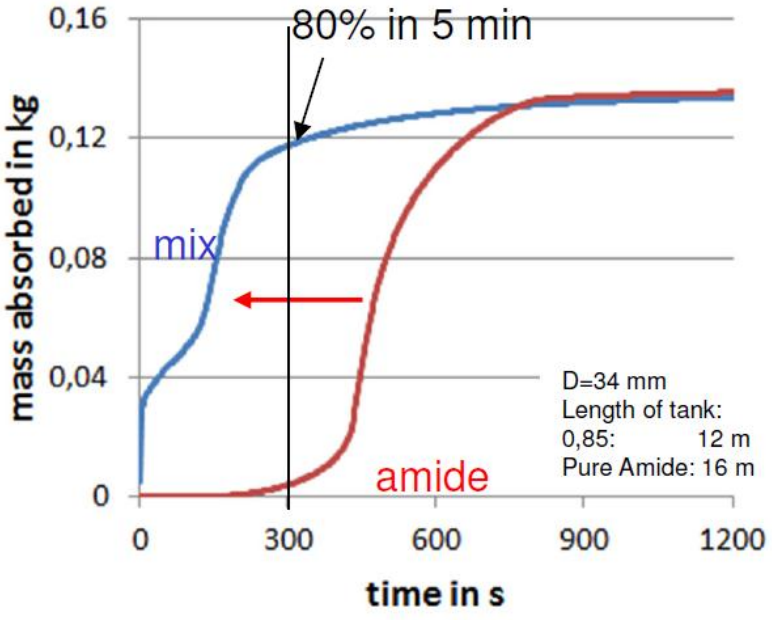


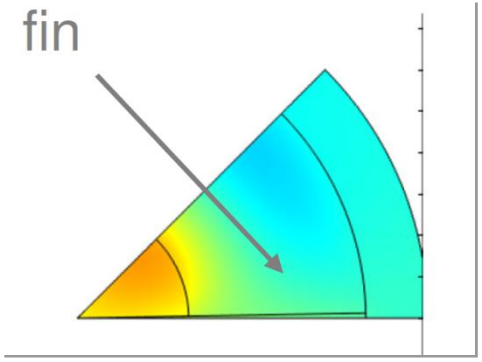
- ***Double** materials used in the tank*
- ***Activation of complex hydride with intermetallic hydride***

PCI of single and double materials

SSH2S results: tank development

- ***Simulation** of laboratory scale tank*
- ***Validation** by experiments with a lab-scale tank*

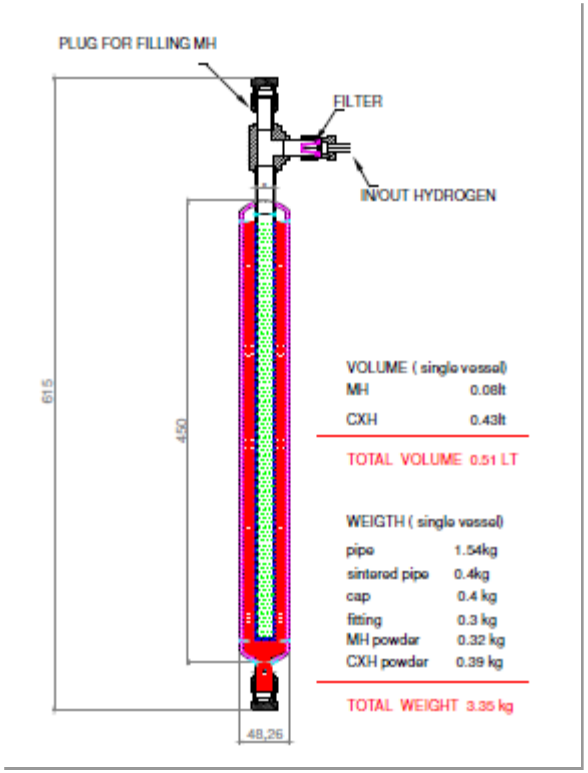


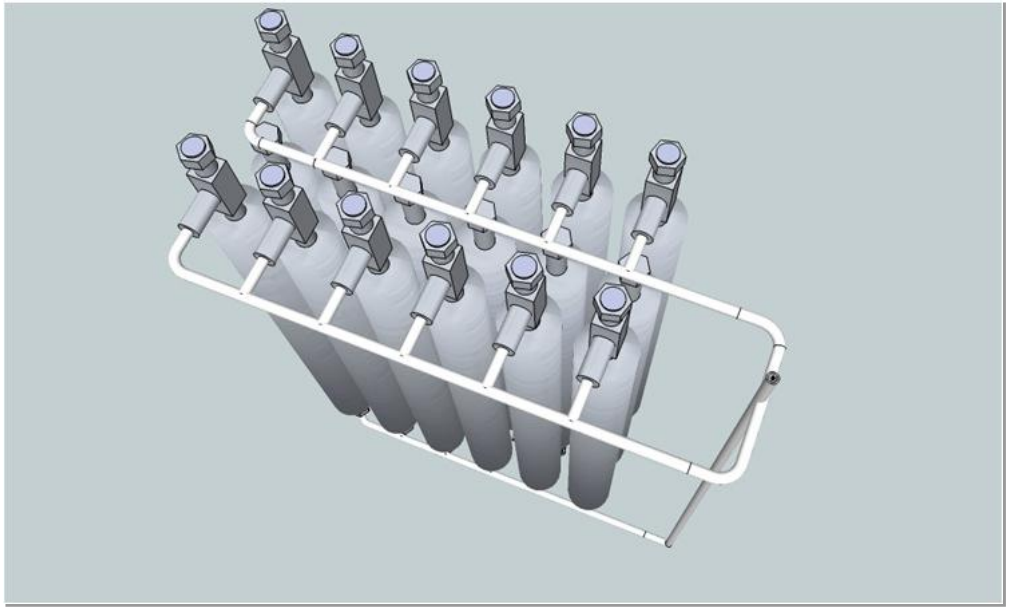


Effect of double material on tank loading

SSH2S results: tank development

- ***Preliminary design of prototype tank***





Scheme of prototype tank

SSH2S results: system integration

- *Preliminary layout of integrated system (1 kW)*
- *Architecture for APU (5 kW)*

Selected Full Electric Vehicle for APU

90 Cell fuel cell stack

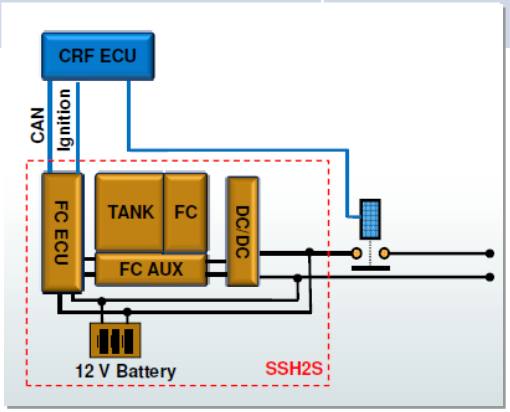
4-5kW peak power

SSH2S vs MAIP/AIP

AA 2: Hydrogen Production, Storage & Distribution

MAIP/AIP targets	*Project goal*	*Project status*	*Gaps bottlenecks in RTD*
Long-term and break-through oriented research on improved solid state hydrogen storage options for increased efficiency and storage capability, i.e. 2nd generation hydrogen storage technology.	*Integrated system to be demonstrated in a prototype system (1 kW) and in APU (5 kW)*	*Preliminary architecture under development. Good material properties*	*Intrinsic properties of materials not yet optimized*

Architecture for Daily Electric

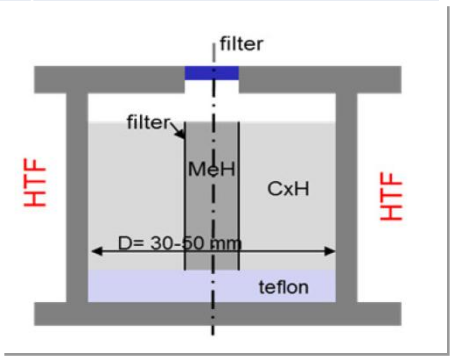


SSH2S vs MAIP/AIP

AA 2: Hydrogen Production, Storage & Distribution

MAIP/AIP targets	Project goal	Project status	Gaps bottlenecks in RTD
Storage materials with capacities ≥ 6 wt.%, ≥ 60 kg H2/m3 reversibly releasing hydrogen at operating temperatures compatible e.g. with PEM FC, HT PEM FC or SOFC / MCFC	Approx. 5 wt% H2 (amides) 7-11 wt% wt% H2 (mixed borohydrides) Double materials concept	Storage materials with capacities up to 4.5 wt% H2 Reversibility at 180 ° C Single reaction step Stability on cycling Stop for mixed borohydrides	Lack of reversibility in new developed materials

Double Materials concept



SSH2S vs MAIP/AIP

AA 2: Hydrogen Production, Storage & Distribution

MAIP/AIP targets	Project goal	Project status	Gaps bottlenecks in RTD
Improved system density for H2 storage (2015: 9 %wt of H2)	4 wt% of H2 4 kg H2/100 L Close to room temperature and pressure	Not yet available Gravimetric density likely lower than goal Volumetric density likely OK	High gravimetric density material with suitable properties not yet available
Cost effective production routes of the materials	< 1250 €/kg H2	Not yet available, but higher than goal	Low production for limited market

HT-PEM for integrated system

SSH2S cross cutting issues

- *Training: 3 PhD student and 4 PostDocs involved in the projec*
- *Safety assessment for the integrated system*
- *Dissemination & public awareness planned: papers, conferences, workshops*
- *Website www.ssh2s.eu*
- *Hydrogen technologies application to common life*






SSH2S cooperations

- *Connections with other FCH-JU projects on solid state hydrogen storage (BOR4STORE, EDEN, HYPER) and on APU (DESTA, FCGEN)*
- *Connections with Working Group "Solid State Hydrogen Storage" inside N.ERGHY*
- *Connections with NEW-IG*
- *Connections with IEA-HIA Task 22*
- *Connections with national and international hydrogen organisations*
- *Technological transfer to SME*

N.ERGHY

New Energy World IG
fuel cells & hydrogen for sustainability

SSH2S acknowledgments

Thank you for your attention

JRC
EUROPEAN COMMISSION

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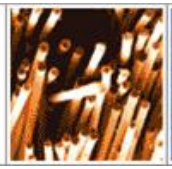
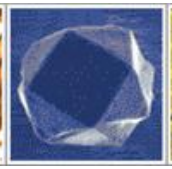


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