

# Hydrogen production by hydrolysis from Mg rich compounds and composites NdNiMg<sub>15</sub>-Mg : How to combine fundamental and applied science?

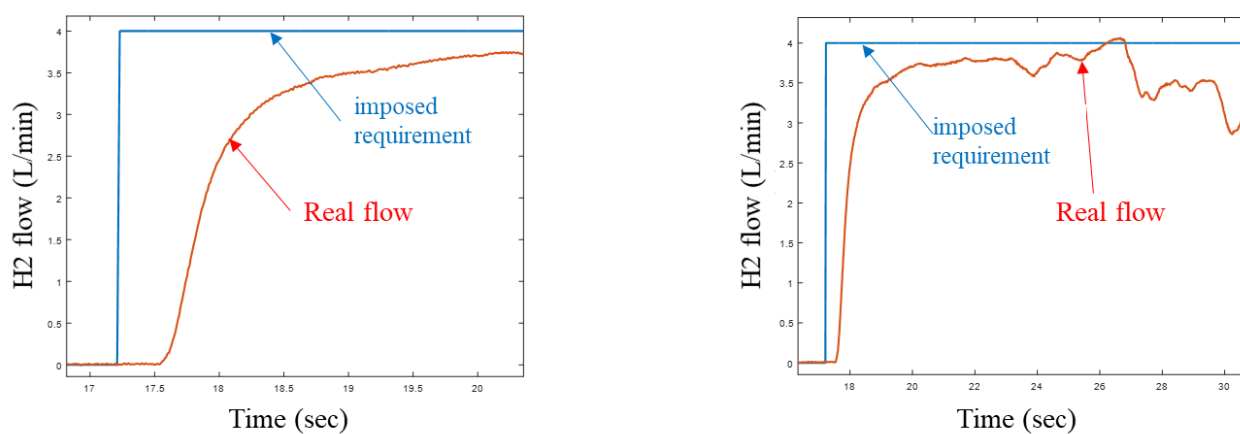
Etienne GAUDIN, Eliane AlAsmar and Jean-Louis BOBET

<sup>a</sup>University of Bordeaux, CNRS, Bordeaux INP, ICMCB, UMR 5026, F-33600, Pessac, France

Journal of Alloys and Compounds

## Supplementary materials

*Test with 6 g of Mg+5wt.%C + 5wt.%Ni ball milled for 3 hours*



*Figure S1 : Hydrogen production (flow) as a function of time for the hydrolysis of 6 g of Mg+5wt.% C + 5 wt.% Ni powder (left figure is a zoom of right one).*

The imposed flow was 4L/min and it was possible to generate 3.8 to 4 L/min for more than 1 minute

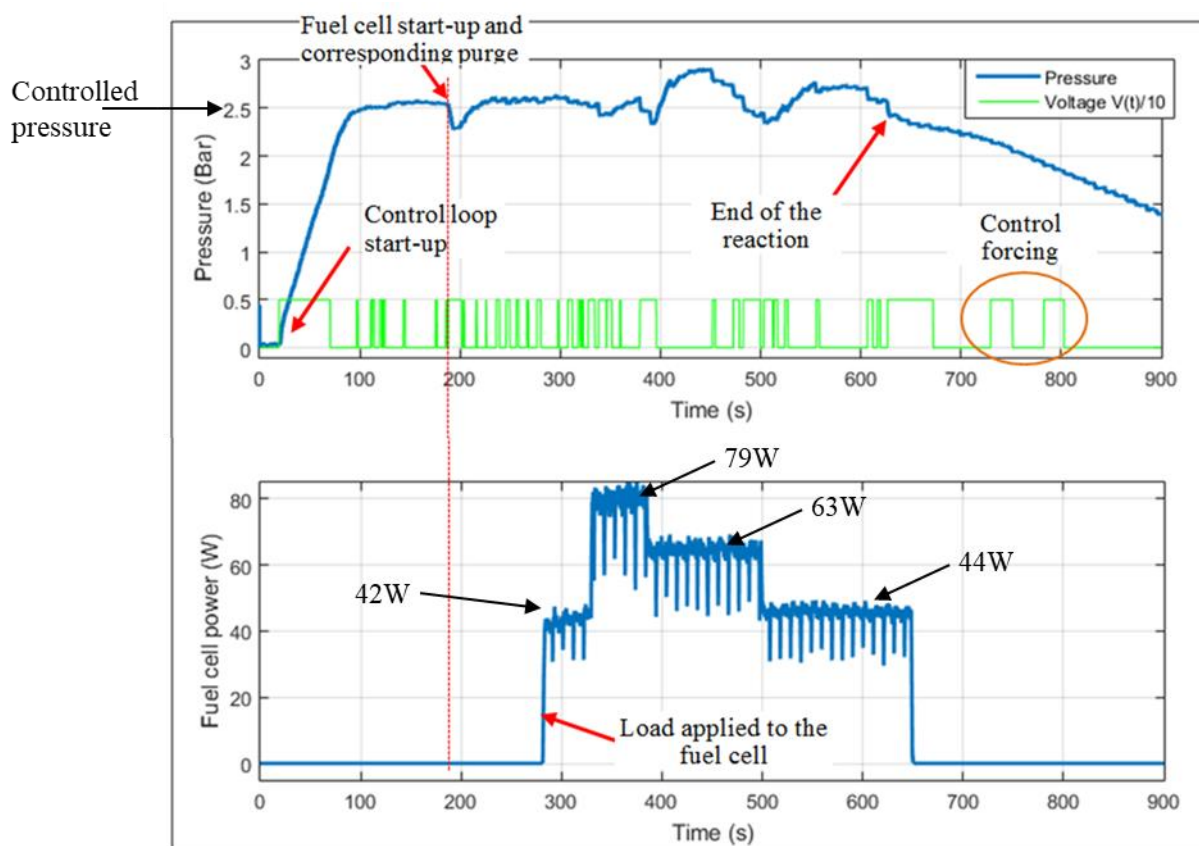


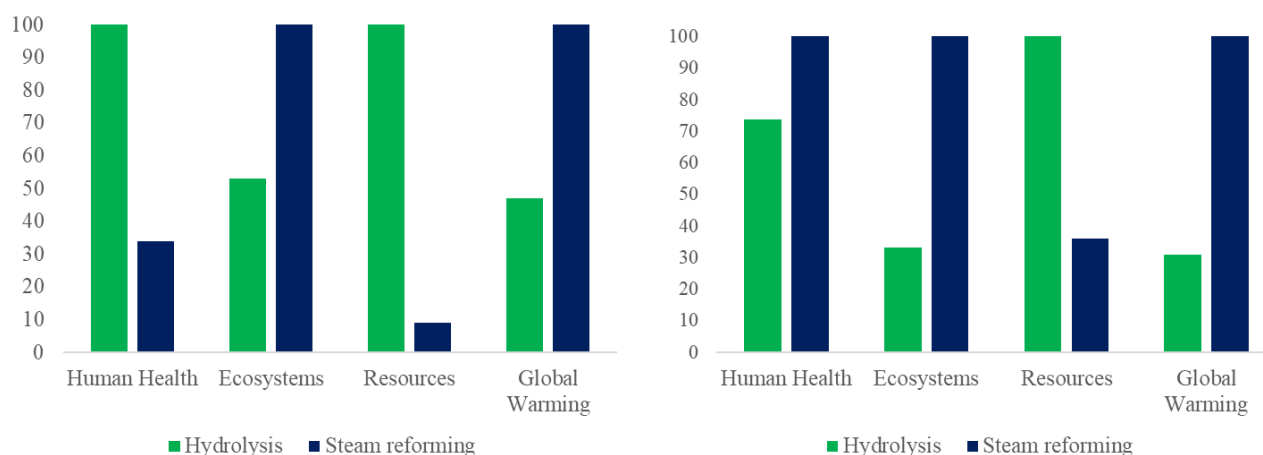
Figure S2 : Adjustable fuel cell power (from 0 to 42, then 79, then 63, then 44 and 0 W) as a function of time. The fuel cell power is adjusted by controlling the water flow (voltage 0/0.5 in green on the top figure) through the magnesium capsule. Test done with 15 g of powder (Mg+5wt.% C + 5 wt.% Ni) [S1-2].

NB : the decrease of the pressure at the end of the reaction is due to some leaks in the system. It is possible to generate power from 100 to 700 seconds (so 10 minutes) at least.

Table S1 : Energy output data for hydrogen production and bike riding. Calculation of the riding distance depending on assistance mode (e.g. Full assistance and 20%)

	Using 100g of magnesium	Using 500g of magnesium
<b>parameter</b>		
Energy Hydrogen (kJ/g)	120	120
density of Hydrogen (g/l)	0,08988	0,08988
density of magnesium (g/l)	1730	1730
Hydrogen Production/Magnesium (g/kg)	83	83
Ratio water weight/Mg weight	1,5	1,5
Hydride weight for storage (kg/l)	0,01	0,01
Kinetic of H2 production (g/mn)	2	2
<b>Input data to specify</b>		
Water volume (kg)	0,15	0,75
Magnesium weight (kg)	0,1	0,5
Yield of electrochemical conversion (PAC, in%)	50	50
electrical yield (%)	80	80
Voltage of the bike motor (V)	12	12
Average power consumed/absorbed by the electrical engine (W)	2000	2000
Average riding speed (km/h)	25	25
<b>Results</b>		
Weight of H2 produced (g)	7,8850	39,4250
Volum of hydrogen produced (l)	87,7281	438,6404
Kinetic energy (kJ)	946,2000	4731,0000
Electrical energy (kJ)	473,1000	2365,5000
Electrical energy (inW.h)	131,4167	657,0833
Amperage produced (A.h)	10,9514	54,7569
Electric power produced all over the reaction (W)	3942,5000	19712,5000
Water weight (kg ou l)	0,1500	0,7500
Volume of magnesium (l)	0,0578	0,2890
Autonomy (s)	236,5500	1182,7500
Autonomy (h)	0,0657	0,3285
<b>Autonomy (km) if full assistance</b>	<b>1,6427</b>	<b>8,2135</b>
<b>Autonomy (km) if 20% assistance</b>	<b>6,5708</b>	<b>32,8542</b>

It appears that with 100g of magnesium, it is possible to ride between 1.6 and 8 km and with 500 g, the distance increase to a minimum of 6 and a maximum of 32 km.



*Figure S3 : The impacts of the impact of hydrogen production by steam reforming and by hydrolysis. On left (figure 4a), the hydrolysis process take into account the nickel and on right (figure 4b), the impact of nickel was deduced from the LCA.*

## References:

- [S1] J.-L. Bobet, F. Bos, F. Mauvy, J. Sabatier, Dispositif de production d'hydrogène pour applications, Patent FR1559518, 2015
- [S2] M. Legree, J. Sabatier, F. Mauvy, A.S. Awad, M. Faessel, F. Bos, J.-. Bobet, 2020, Autonomous Hydrogen Production for Proton Exchange Membrane Fuel Cells PEMFC, Journal of Energy and Power Technology 2(2),004. <https://doi.org/doi:10.21926/jept.2002004>.