Hydrogen storage in nanosized magnesium hydride doped with niobium pentaoxide and graphite

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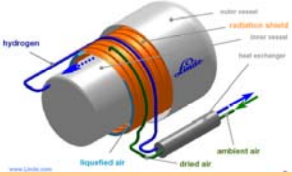
The problem of hydrogen storage

Hydrogen is the ideal means of storage, transport and conversion of energy for a comprehensive clean-energy concept. Regarding the use of hydrogen as energy vector for the zero-emission vehicles, one of the problems is the *storage of hydrogen*.



Compressed hydrogen

- **high pressure (up to 700 atm)**
  safety problems
- **high energy cost for compression**

Liquid hydrogen (20K)

- **low temperature needed**

safety problems

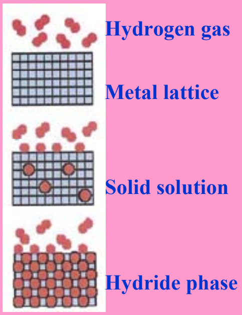
Metal hydrides

- **higher volumetric hydrogen content compared with liquid and compressed hydrogen**
- **release of hydrogen in certain conditions of pressure and temperature**

no safety problems

Properties of metal hydrides

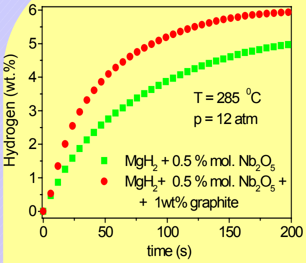
Host material initially dissolves some hydrogen as a solid solution. As H pressure and concentration in the host increases, nucleation and growth of the hydride occurs.

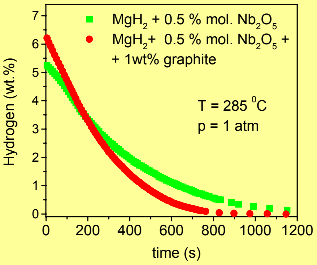


Problems

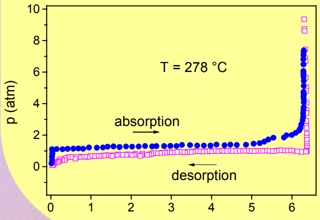
- **Low hydrogen content by weight**
- **High desorption temperature**
- **Poor kinetics of the system(improved by appropriate catalysts and ball milling)**

Metal	Hydride	wt. %	P , T
Pd	$PdH_{0.6}$	0.56	0.02 atm , 298 K
$LaNi_5$	$LaNi_5H_6$	1.37	2 atm , 298 K
ZrV_2	$ZrV_2H_{5.5}$	3.01	10^{-8} atm , 323 K
FeTi	$FeTiH_2$	1.89	5 atm , 303 K
Mg_2Ni	Mg_2NiH_4	3.59	1 atm , 555 K
TiV_2	TiV_2H_4	2.6	10 atm , 313 K
Mg	MgH_2	7.6	1 atm , 558 K





- ***MgH_2+0.5% mol Nb_2O_5+1% wt graphite*** absorbs 6.3 wt% of hydrogen (5.9 wt% in 200 s) and desorbs 5.8 wt% in 600 s
- ***Pure MgH_2*** absorbs the same amount of hydrogen at 374°C and 20 atm (3.5 wt% in 200 s)

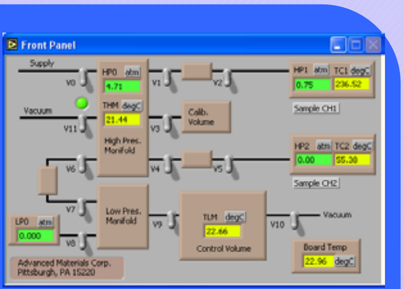


PCI for *MgH_2+0.5% mol Nb_2O_5+1% wt graphite*

displays a thin hysteresis cycle and a plateau pressure close to that for pure MgH_2

Gas Reaction Controller

Instrument supplied by AMC Pittsburgh and recently set up in our laboratory

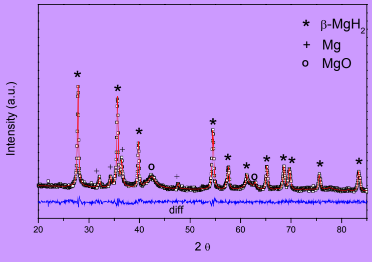


HP0 atm 4.71
THM degC 21.44
HP1 atm 0.75
TC1 degC 236.52
HP2 atm 0.00
TC2 degC 55.30
LP0 atm 0.000
TLM degC 22.66
Board Temp 22.96 degC

- **Sievert volumetric apparatus working in automatic mode**
- **PCI (Pressure Composition Isotherm) and kinetics measurements**
- **p = 0÷200 atm , T = 20÷500 °C**

XRD pattern of ball milled MgH_2+0.5 mol% Nb_2O_5+1 wt% C in argon for 20 h using a Spex 8000 mill after several hydrogen absorption/desorption cycles

Rietveld refinement to improve qualitative and quantitative informations



Conclusions

- ☺ **The addition to pure MgH_2 of niobium pentaoxide and graphite improves the absorption/desorption kinetics but does not change the thermodynamics of the system;**
- ☺ **It is supposed that graphite influences the nature of nucleation sites and prevents the formation of magnesium oxide.**