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Materials Energy Research Laboratory in Nanoscale

Hydrogen for Industry Technologies

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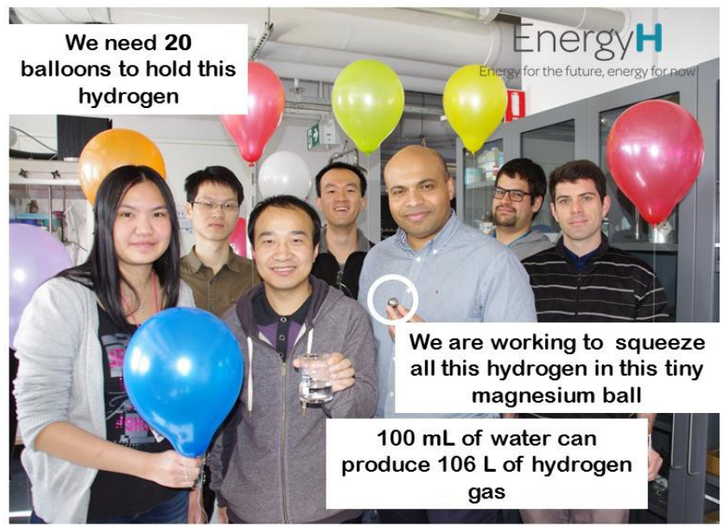
www.merlin.unsw.edu.au

MERLIN
Materials Energy Research Laboratory in nanoscale



Hydrogen is the Ultimate Energy Carrier

- ✓ An unlimited clean source of energy, with pure water being the only emission;
- ✓ The highest energy density of all fuels;
- ✓ A fuel that when used produces its own feedstock, i.e. water;
- ✓ Universally available – can be safely produced and used in our homes;
- ✓ With application not only in energy but also in a range of unforeseen technologies.

Petrol

12 kWh/kg

10 kWh/L

Li-ion

0.2 kWh/kg

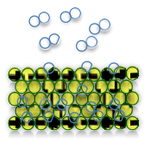
0.5 kWh/L

Compressed H_2 700 bar

100 mass% H_2

2 kWh/kg

1.5 kWh/L

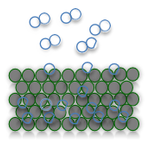


$LaNi_5H_6$

1.8 mass% H_2

0.6 kWh/kg

3.5 kWh/L

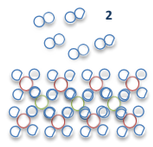


MgH_2

7. 6 mass% H_2

3 kWh/kg

4 kWh/L



$LiBH_4$

18 mass% H_2

6 kWh/kg

5 kWh/L

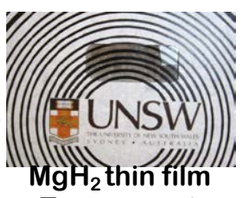
At MERLin, we are developing solutions for making the use of hydrogen a reality across various sectors

Switchable Mirrors

We are developing new hydrogen thin film materials for making buildings more energy efficient

Mg thin film
Metallic/Reflective

With increasing hydrogen concentrations the thin film switches from a metallic to a transparent state.
The reaction is fully reversible



MgH_2 thin film
Transparent

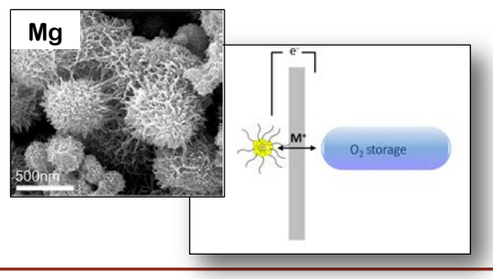
- ✓ Smart windows for efficient heat and light regulation in buildings;
- ✓ A 30% increase in energy efficiency in buildings could cut CO_2 emission by 7% in Australia.

Other application:

- ✓ Switchable heat absorbers (e.g. heat regulation in combined photovoltaic/thermal solar collector devices);
- ✓ A 20% increase in efficiency for solar power generation.

Metal-Air Batteries

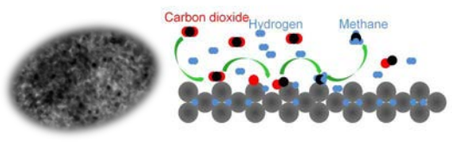
We are developing better batteries based on hydrogen storage nanomaterials



Mg/Air battery: low cost, light, non-toxic, and high theoretical gravimetric energy density of 3910 $Wh.kg^{-1}$

$2Mg + O_2 + 2H_2O \rightarrow 2Mg(OH)_2$ 3.1 V

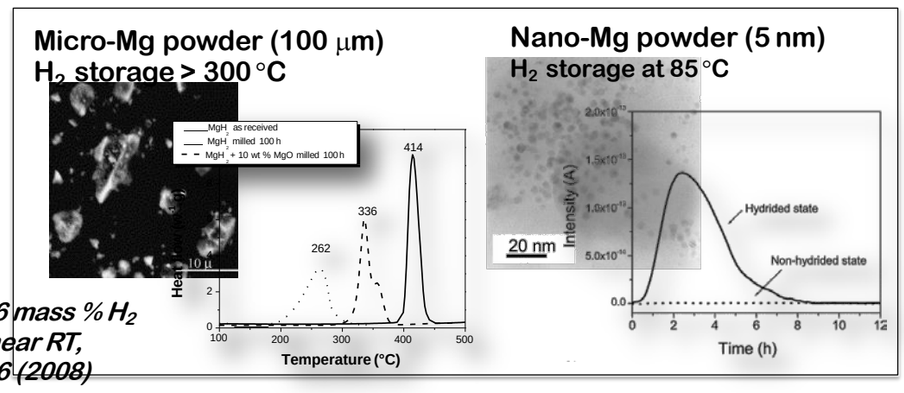
We are developing new methods to convert carbon dioxide into synthetic fuels with metal hydrides catalysts



CO_2 can be effectively converted back to methane and various fuels with high conversion rates and selectivity (99 %)

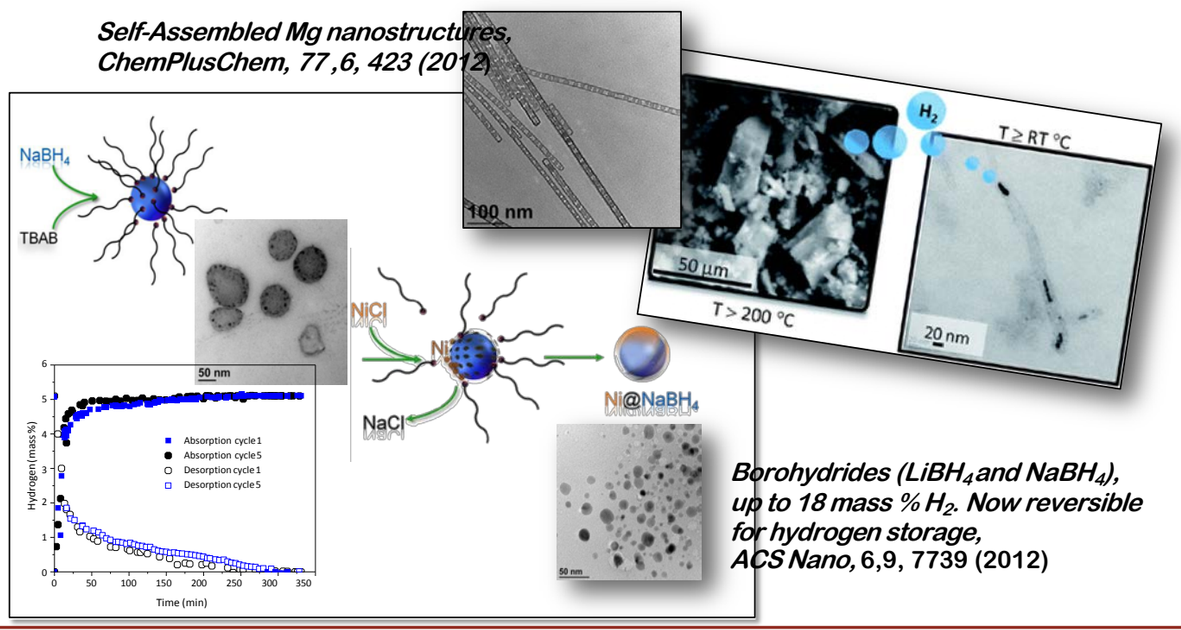
Hydrogen Storage

We are developing better materials to store hydrogen with high density



Magnesium (Mg), 7.6 mass % H_2 can now be cycled near RT, Chem. Mater. 20, 376 (2008)

Self-Assembled Mg nanostructures, ChemPlusChem, 77 ,6, 423 (2012)

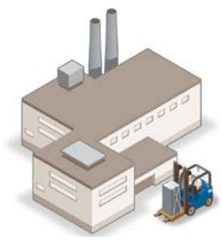


Borohydrides ($LiBH_4$ and $NaBH_4$), up to 18 mass % H_2. Now reversible for hydrogen storage, ACS Nano, 6,9, 7739 (2012)

Applications of H_2

Household and mobility

Industry and chemicals manufacturing



Renewable energy integration

www.merlin.unsw.edu.au/EnergyH

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