

# HYDROGEN ENERGY STORAGE FOR ON-BOARD FUEL CELLS, CONCENTRATED SOLAR POWER AND SECONDARY BATTERIES

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# ENERGY STORAGE

## Solar Thermal Storage

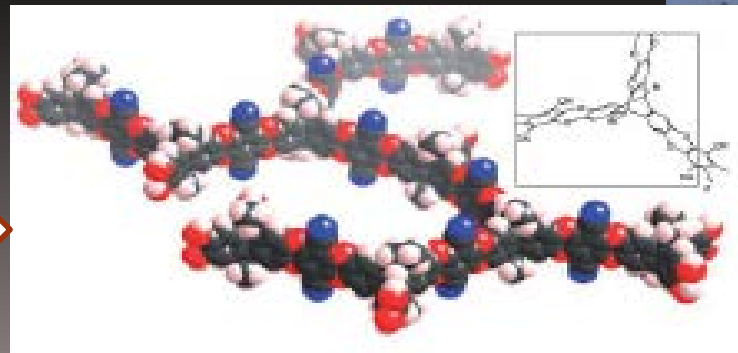
- Phase Change Materials
- Hydrides/Hydrates

## Electrochemical Storage

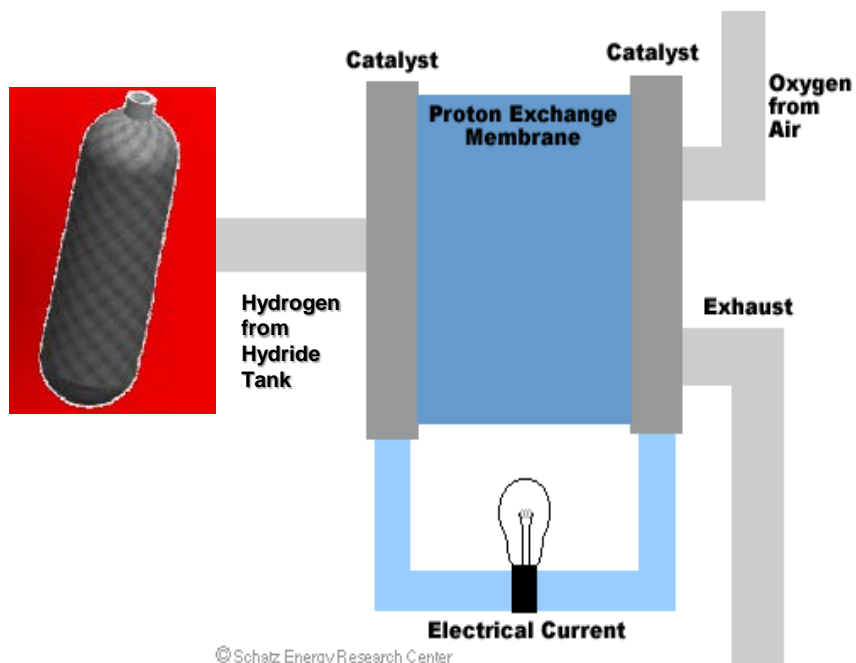
- Li-ion Batteries
- Metal Hydrides Batteries

## Hydrogen Storage

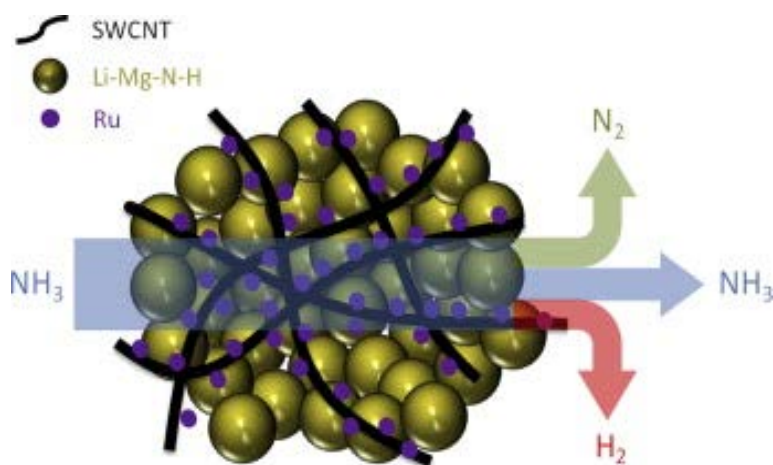
- Physisorption
- Chemisorption



# Hydrogen Storage Materials For Fuel Cell Vehicles



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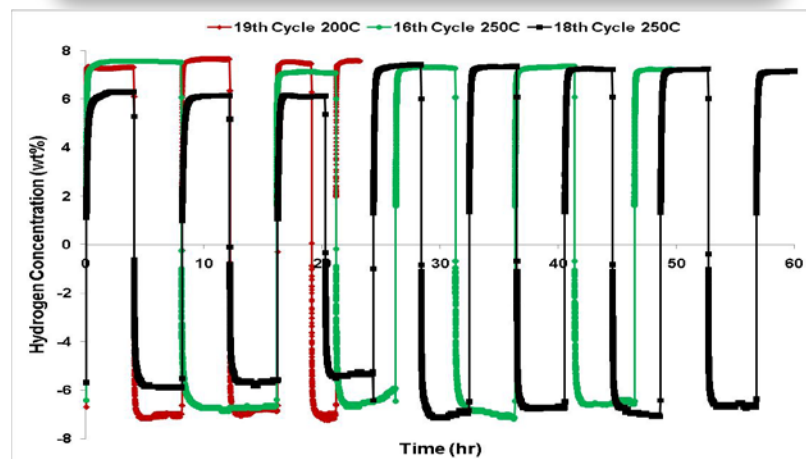


System Volumetric Capacity

System Gravimetric Capacity

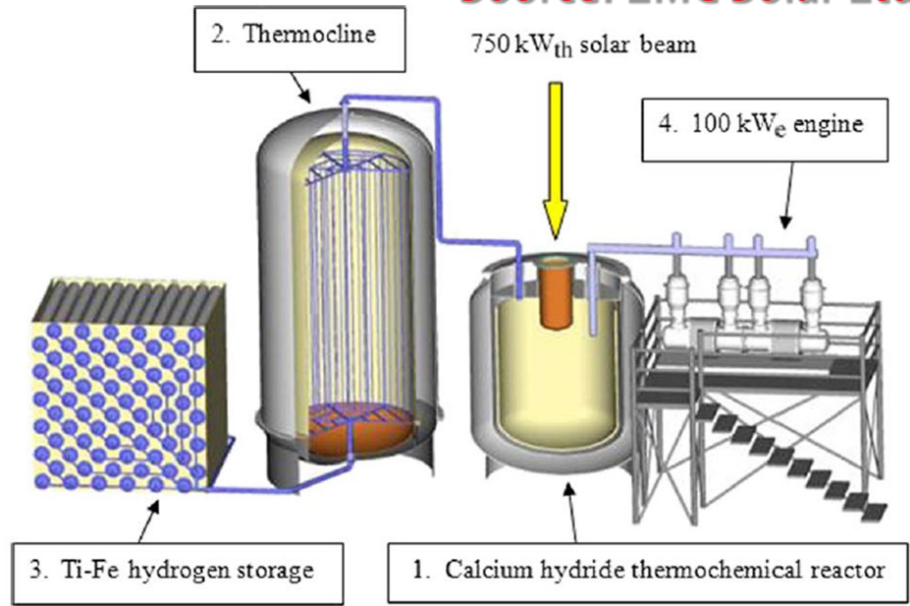
Storage System Cost

Durability / Operability



# Hydrogen Storage Materials For Conc. Solar Power

Source: EMC Solar Ltd.

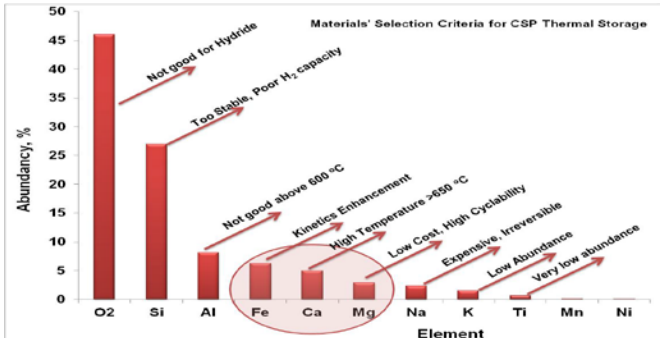
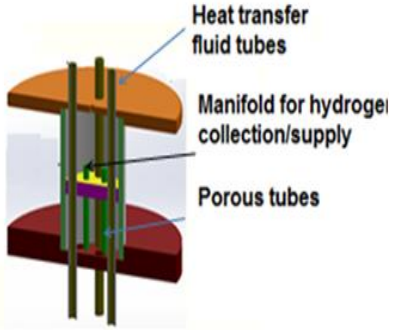
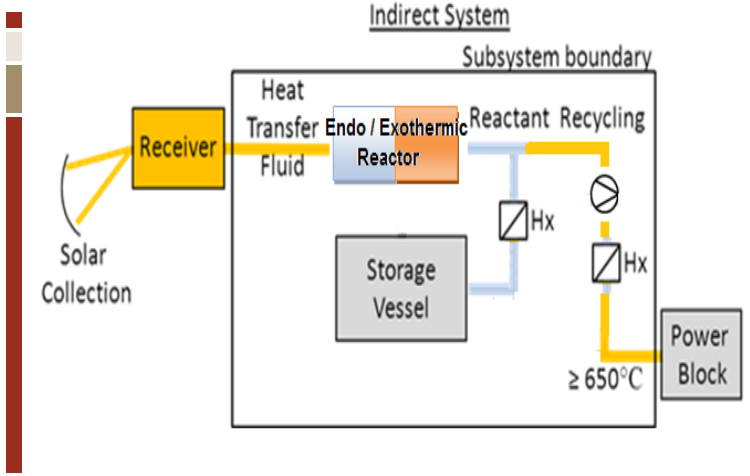


Temperature Swing Hydrides

Volumetric Storage Capacity

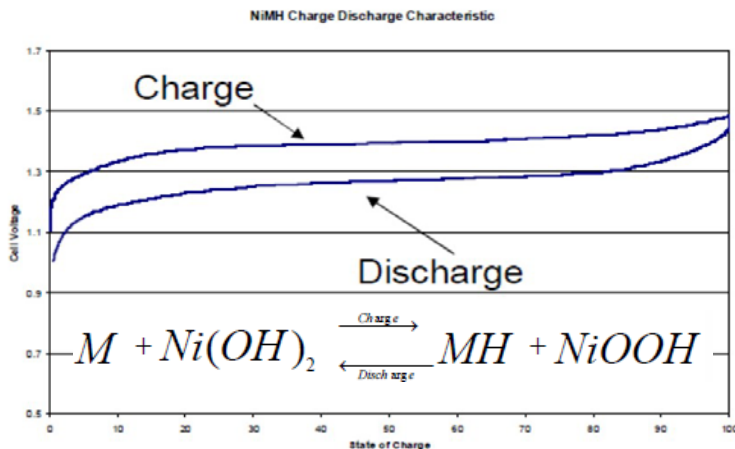
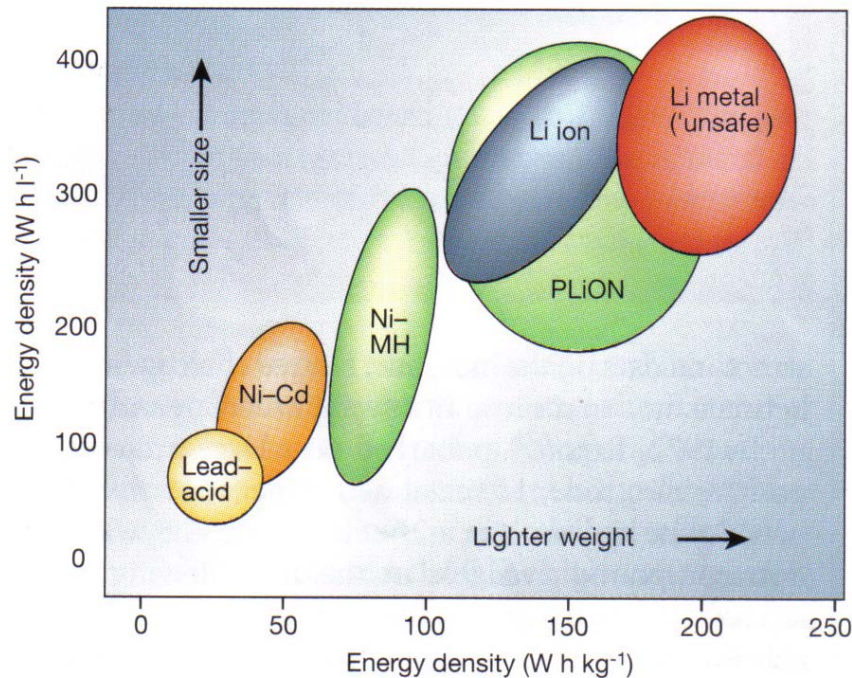
Exergetic Efficiency

Reaction	Enthalpy (kJ/mol)	$\Delta G/\Delta H$ Value (%)	Energy Density		Reaction Extent (%)
			(kJ/kg)	(kJ/m <sup>3</sup> )	
$\text{Ca} + \text{H}_2 \leftrightarrow \text{CaH}_2$	181	~80	4494	~6.0X10 <sup>6</sup>	95
$\text{CaH}_2 + \text{Fe} \leftrightarrow \text{Ca}_2\text{FeH}_6$	~150	~95	~3660	~4.5X10 <sup>6</sup>	~ 90
$4\text{CaH}_2 + 3\text{MgH}_2 \leftrightarrow \text{Ca}_4\text{Mg}_3\text{H}_{14}$	~130	~72	~3650	~4.0X10 <sup>6</sup>	~95
$4\text{CaH}_2 + 4\text{MgH}_2 + 3\text{Fe} + 3\text{H}_2 \leftrightarrow \text{Ca}_4\text{Mg}_4\text{Fe}_3\text{H}_{22}$	~165	~74	~3500	~3.5X10 <sup>6</sup>	~90





# Hydrogen Storage Materials For Secondary Batteries



Energy Storage Density

Power Density

Recyclability / Life Cycle

Materials Safety & Cost

