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High Pressure Hydrogen Storage Systems

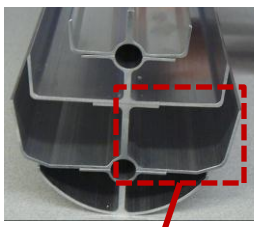
Bulk Hydrogen Storage System

- 22 ft^3 of 6000 psi hydrogen storage
- Dual stage compressor
- Sized for propulsion and automotive applications
- Remotely controlled

High Pressure Metal Hydride Testing Facility

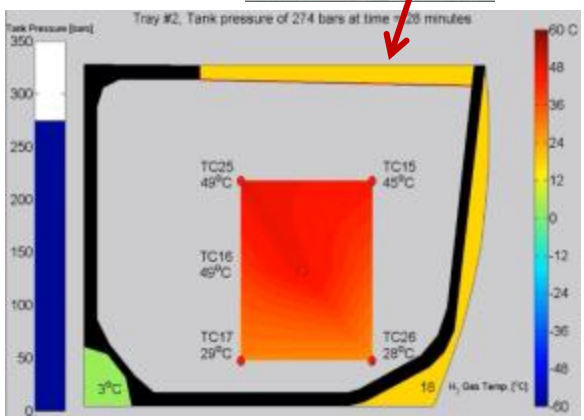
Glovebox Workstation

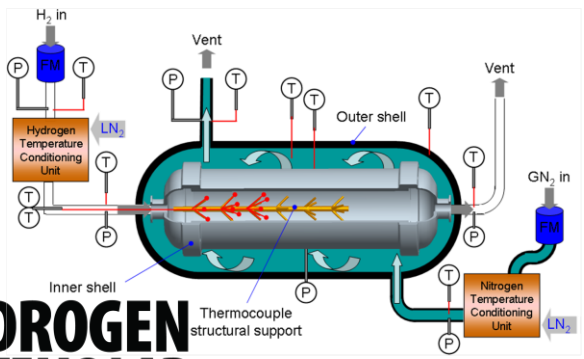
- 6 port glovebox
- Argon atmosphere maintained at < 0.1 ppm H_2O and < 0.1 ppm O_2
- 1.5 m^3 of working space



Storage of Hydrogen Gas in High Pressure Metal Hydrides

- Multiple kilogram scale hydrogen storage systems
- System rated to 410 bar; remotely controlled
- Storage systems designed and successfully tested to fill hydrogen within 5 min
- Analytical and CFD models of the filling process that accurately match with the experimental results
- 10 kW chiller (max. flow rate 60 liters/min from 0 to 30˚C)





Hydrogen Storage in Cryogenic Sorbent Materials

- Multiple kilogram scale hydrogen storage system
- System rated and operated at 70 bar & 77 K
- High instrumentation channel capability

HYDROGEN SYSTEMS LAB

Research in collaboration with General Motors

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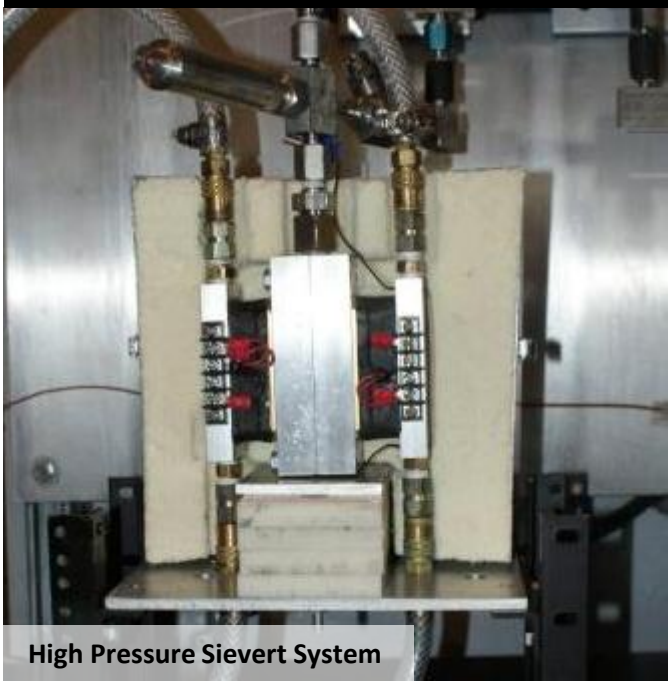
Hydrogen Storage Materials Property Characterization

High Pressure Sievert System

- Characterize hydrogen storage materials at pressures and temperatures expected for vehicle operation
- Study metal hydrides (TiCrMn and $LaNi_5$)
- Ongoing project to study adsorbent materials at room temperature and high pressure

SYSTEM SUMMARY

- Hydrogen absorption up to 700 bar H2 gas
- Operates between -30°C and 80°C using computer-controller thermoelectric coolers
- Verified with LaNi5, a well-known hydrogen storage material



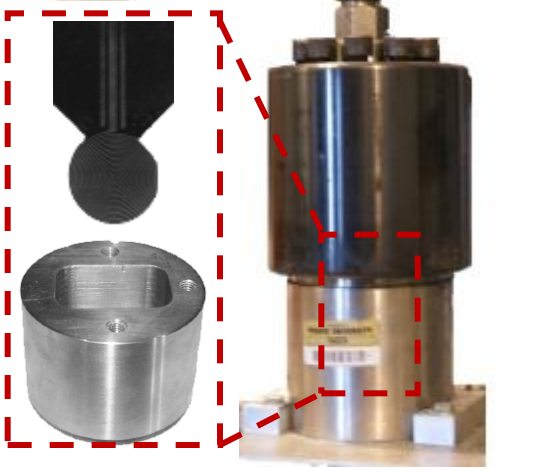
High Pressure Sievert System

In Situ Thermal Property Measurement

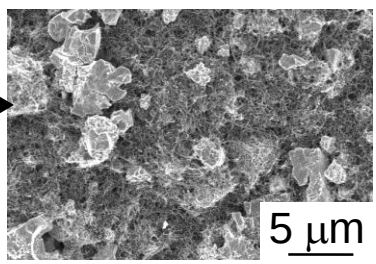
- Measure thermal conductivity, thermal diffusivity, and volumetric specific heat of powders, pellets, and composite materials via transient heating methods (plane source and hot wire methods).
- Knowledge of these properties is critical for the utilization of solid-state materials for hydrogen storage.

SYSTEM SUMMARY

- Designed for operation at up to 630 bar H_2 gas
- Wide sample size range
- Precise measurement of thermal conductivity from insulators to electronic conductors
- Study enhancement of metal hydride conductivity with polymers, metals, and carbon nanotubes



Metal hydride-carbon nanotube composite



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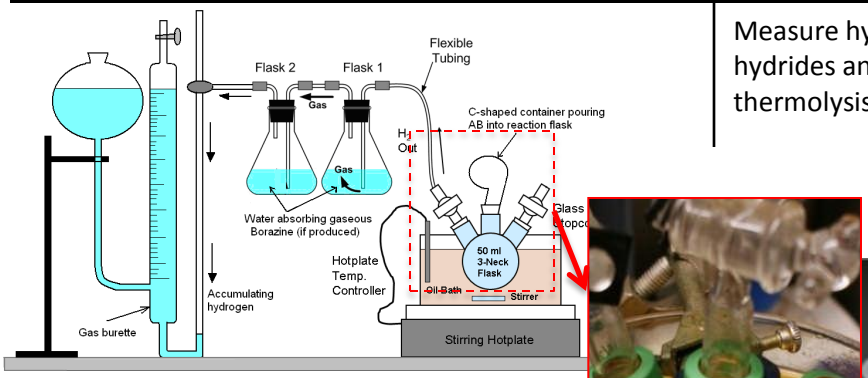
Hydrogen Storage in Chemical Hydrides

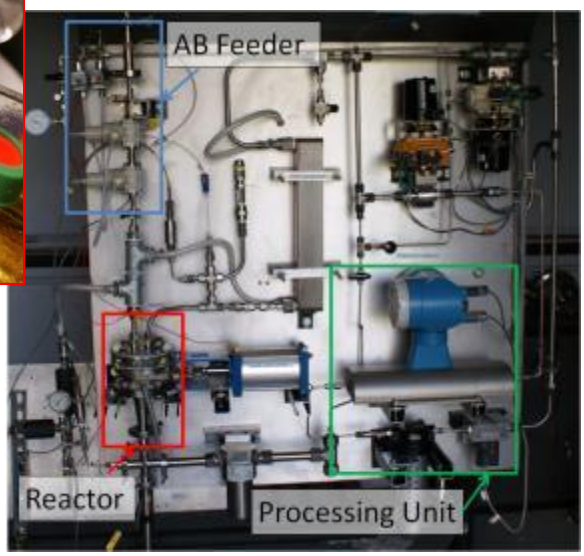
From Science & Engineering to Vehicle Demonstration…



Heated bath reactor for thermolysis & hydrothermolysis of chemical hydrides

Measure hydrogen yield and kinetics of chemical hydrides and derivatives at 1/10th gram scale, including thermolysis and hydrolysis of:

- Ammonia Borane (NH_3BH_3, AB)
- Water and Ionic Liquid based AB slurries
- Sodium borohydride, $NaBH_4$

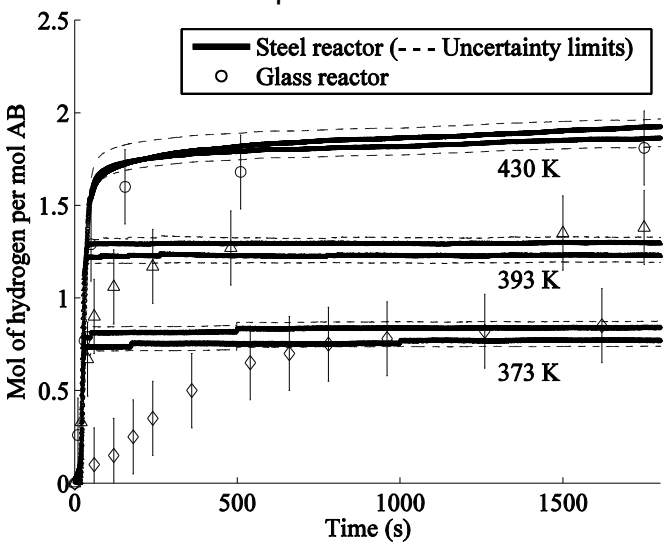


Multiple Gram Reactor

- Analysis of industrial scale-up with a multi-gram pellet reactor
- Quantification of reaction yield and kinetics
- Demonstration on a mobile platform, fueling a hydrogen internal combustion engine
- Ammonia sequestration for fuel cell applications

Above: Multi-gram thermolysis reactor
Below: H_2 yield rates in stainless-steel & glass reactors. Temperatures refer to heater set point.

Capstone: adapted & demonstrated Club Car IC engine with AB thermolysis reactor



Research in collaboration with the US Department of Energy

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