Metal Hydrides for Hydrogen and Helium Recovery and Purification

Michael D. Hampton
UCF Department of Chemistry

Darlene K. Slattery
Florida Solar Energy Center

Start Date = June, 2002
Planned Completion = December, 2006

Research Goals and Objectives

- **Develop chemical system(s) capable of separating hydrogen from helium and capturing hydrogen boil-off**
  - **Determine the effects of aluminum addition**
  - **Determine effect of cycling**

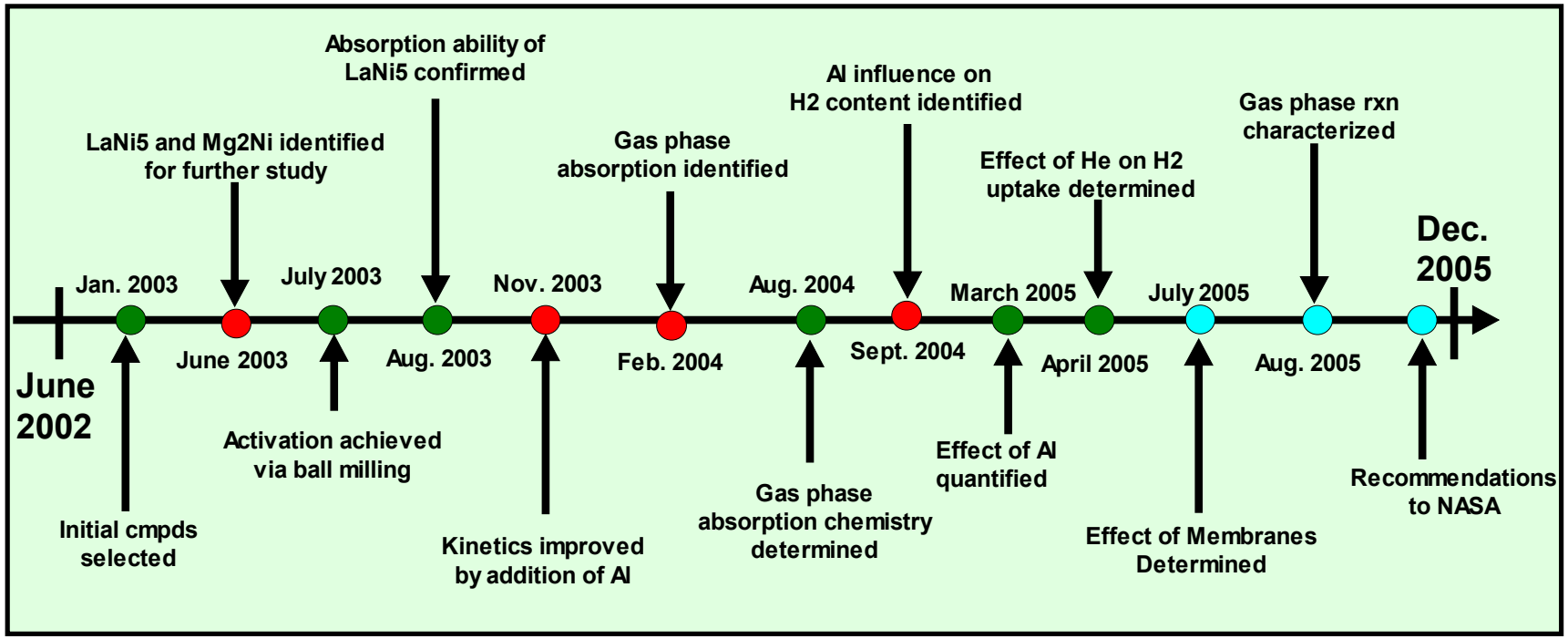
Relevance to Current State-of-the-Art

- Metals and alloys are currently under intense investigation as hydrogen storage media. The work here extends the application of these materials to hydrogen and helium separation and purification.

Relevance to NASA

•The materials developed will provide for conservation of resources and funds at KSC by allowing the recovery and re-use of hydrogen and helium

Budget, Schedule and Deliverables



Anticipated Technology End Use

- Conservation and re-use of hydrogen and helium at KSC
- Recovery of boil off or vented hydrogen at hydrogen refueling stations and storage facilities
- Safety systems for facilities in case of hydrogen leaks
- Hydrogen getters

Accomplishments and Results

Technical

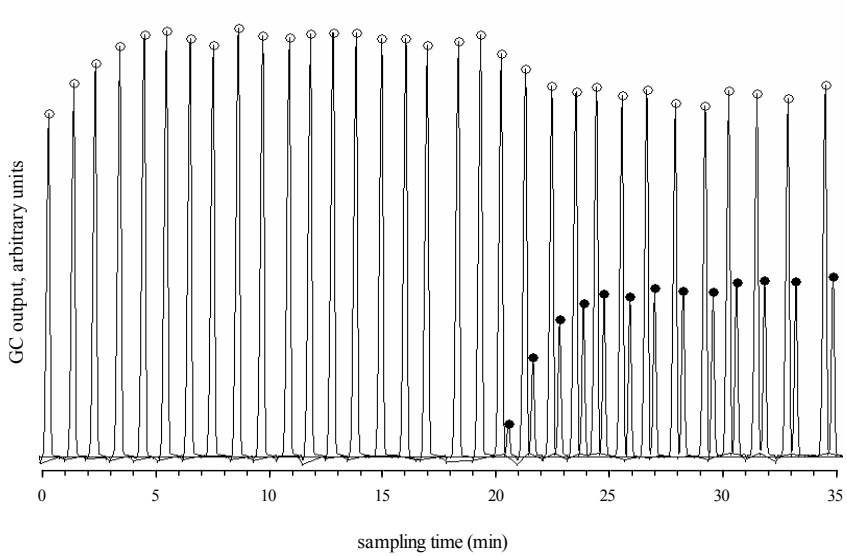
- Determination that $LaNi_5$ can be used to purify He to NASA specifications
- Determination that $LaNi_5$ can be used to capture hydrogen from boil-off
- Determination that Al improves kinetics of hydrogen uptake by $LaNi_5$ with little reduction in capacity
- Lanthanum nickel loses little capacity with extended cycling
- Lanthanum nickel with aluminum added shows similar results but with greater loss in capacity
- Development of a gas phase system that allows for rapid capture of hydrogen

Publications and Collaborations

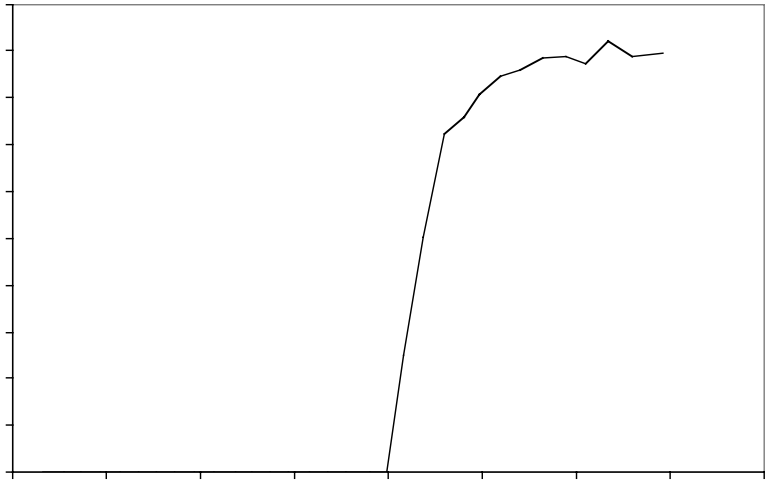
- "Hydrogen Uptake Characteristics of Mechanically Alloyed Ti-V-Ni" J. Alloys Comp. 2005, in press.
- "Effect of Aluminum on H_2 Uptake Properties of $LaNi_5$", in preparation for submission to International Journal of Hydrogen Energy.
- Manoj K. Ram, Fractal Systems, Inc., Safety Harbor, FL
- Danesh Chandra, University of Nevada, Reno
- Fereshteh Ebrahimi, University of Florida

Personnel

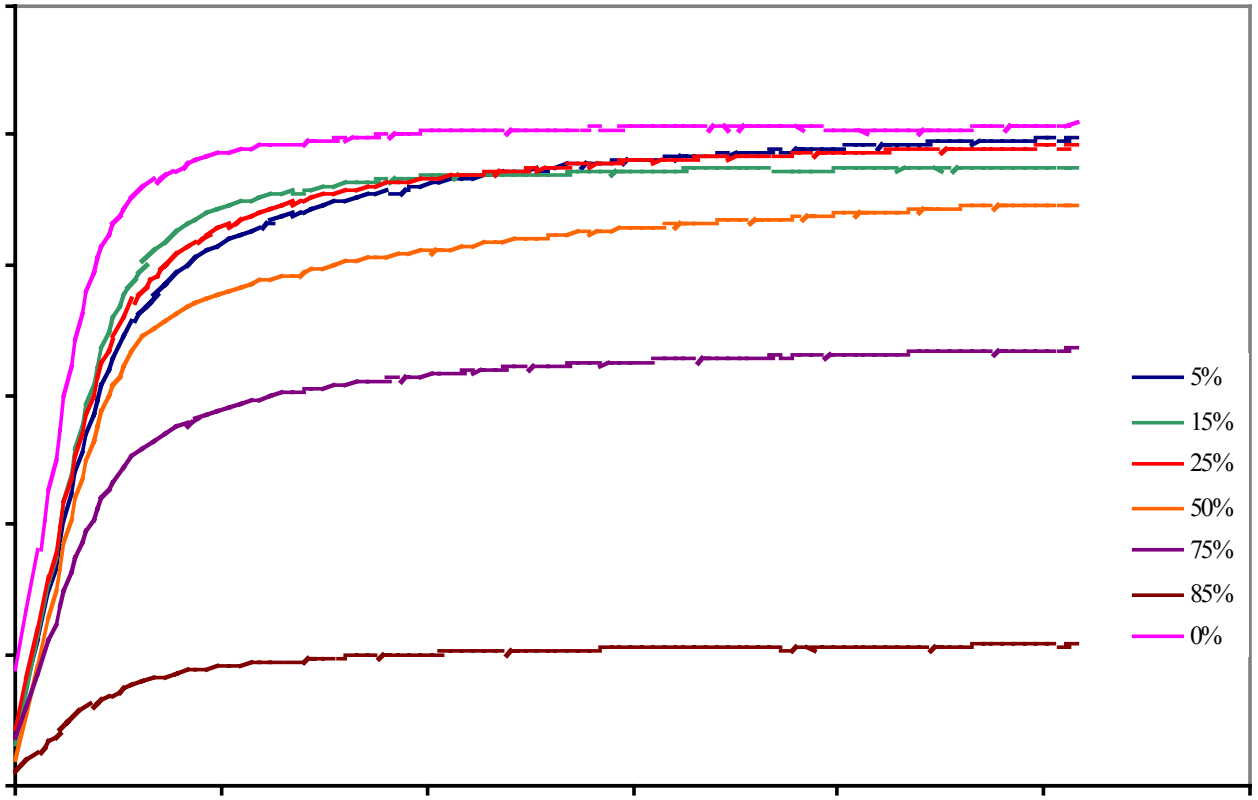
- Muzaffer Tonguc Oztek, MS Degree, Industrial Chemistry



Chromatogram for hydrogen absorption in the U-tube reactor

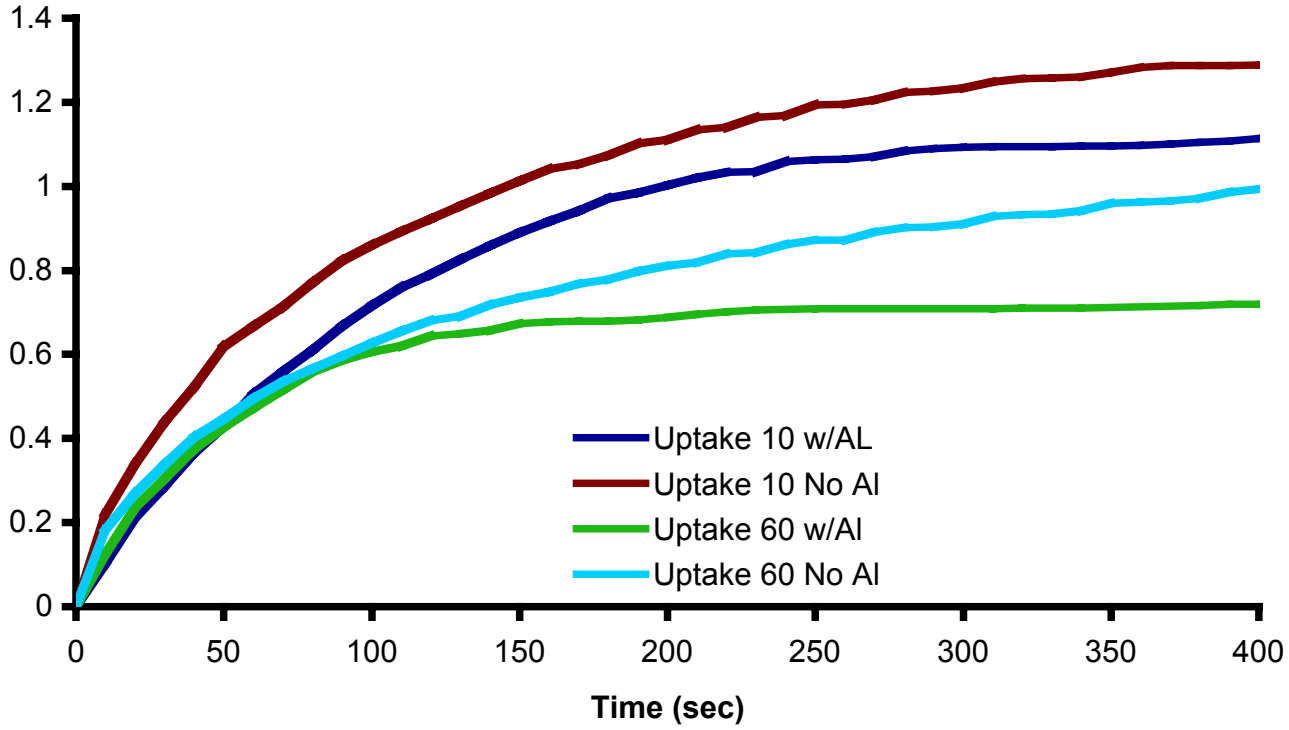


Effluent gas composition as percent hydrogen

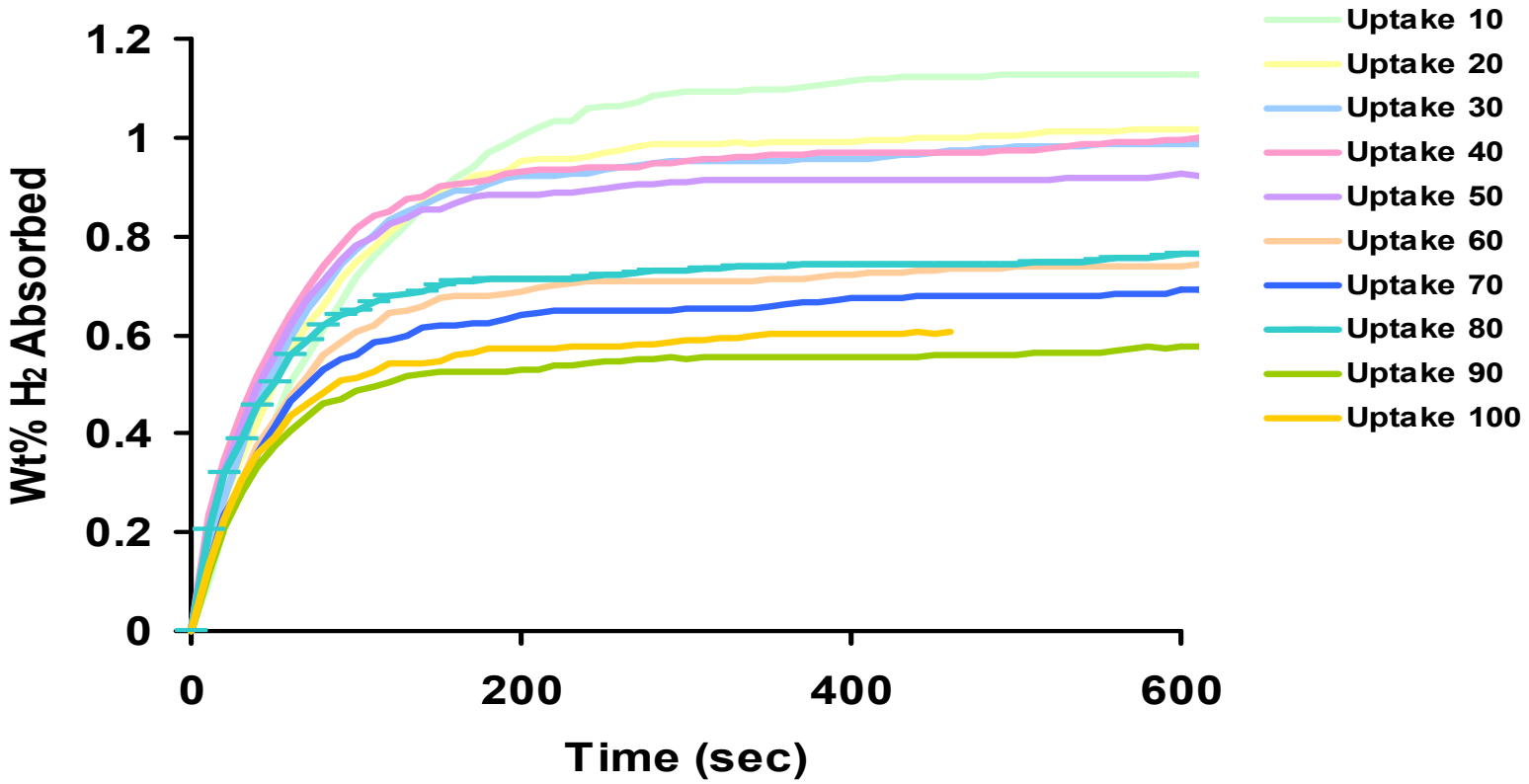


Percent hydrogen uptake curves for different amounts of Al in $LaNi_5$

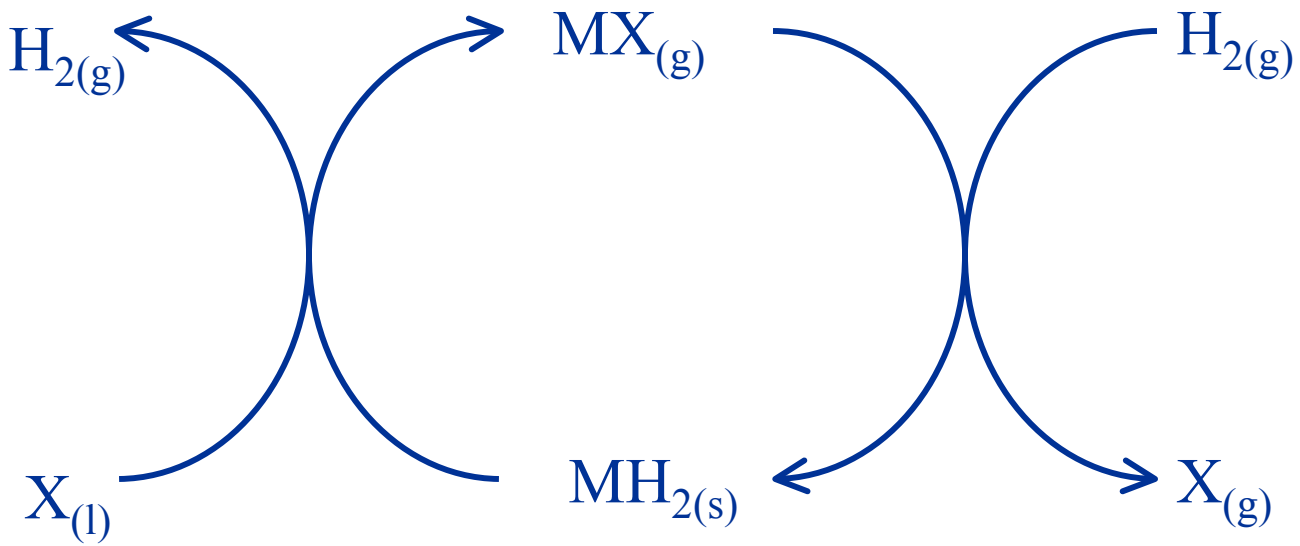
Cycling Comparison With and Without Al



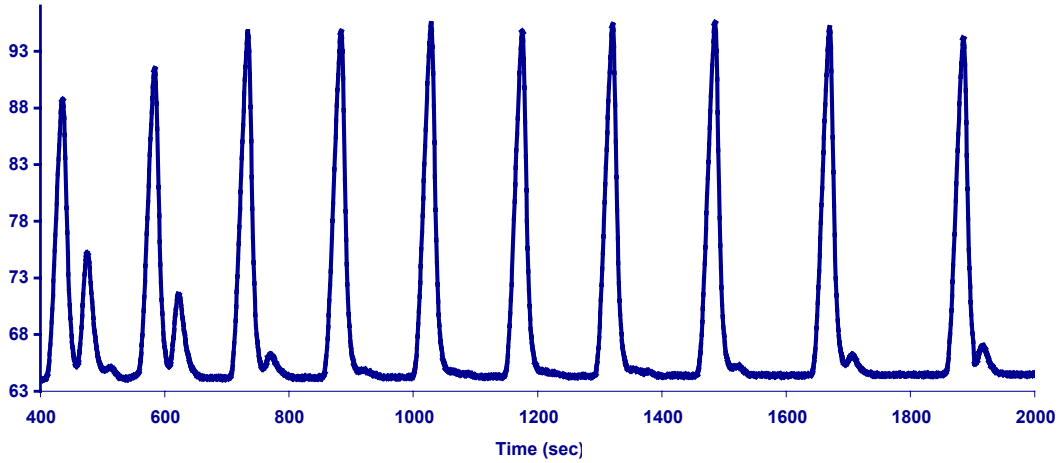
Lifetime Study for $LaNi_5$ with 11.4 Atomic% Al

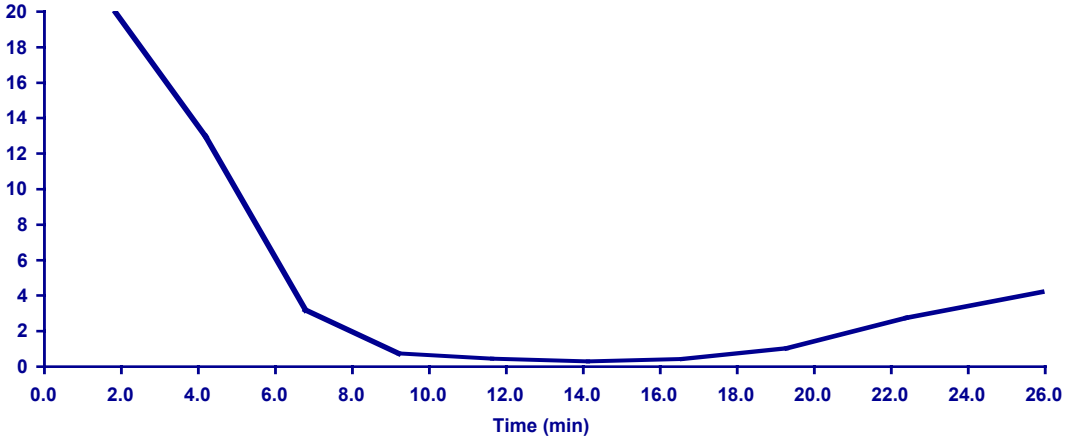


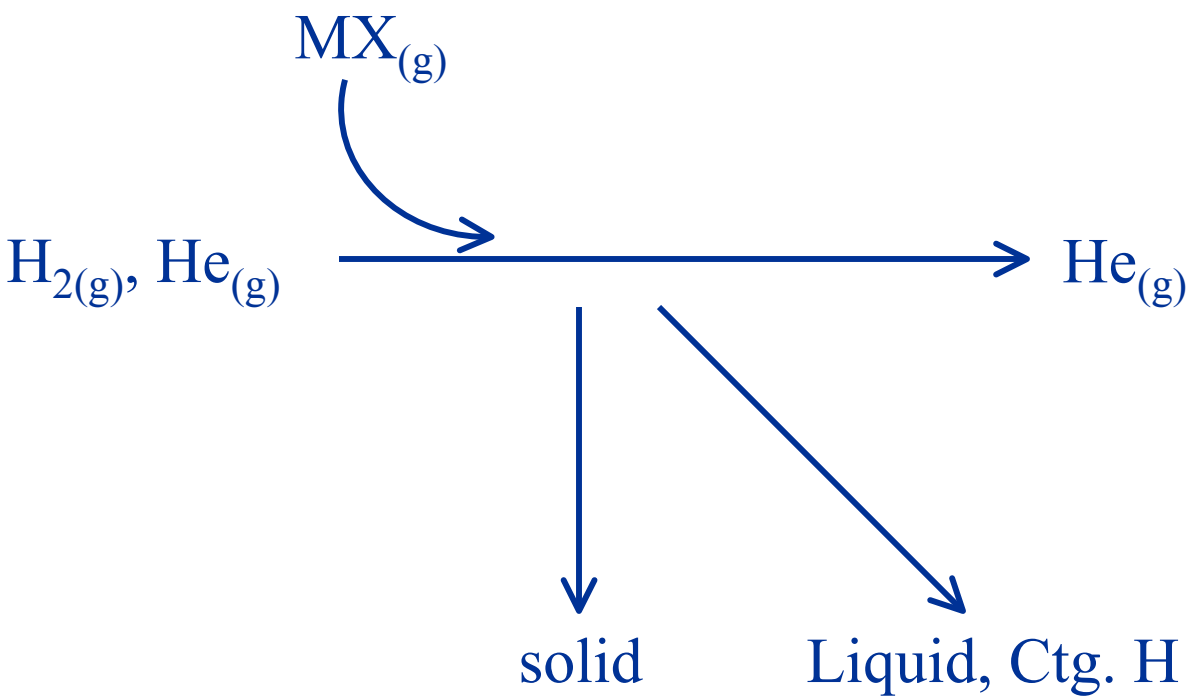
Gas Phase Reaction



Gas Phase Results






$MX_{(g)}$
$H_{2(g)}$, $He_{(g)}$
$He_{(g)}$
solid
Liquid, Ctg. H

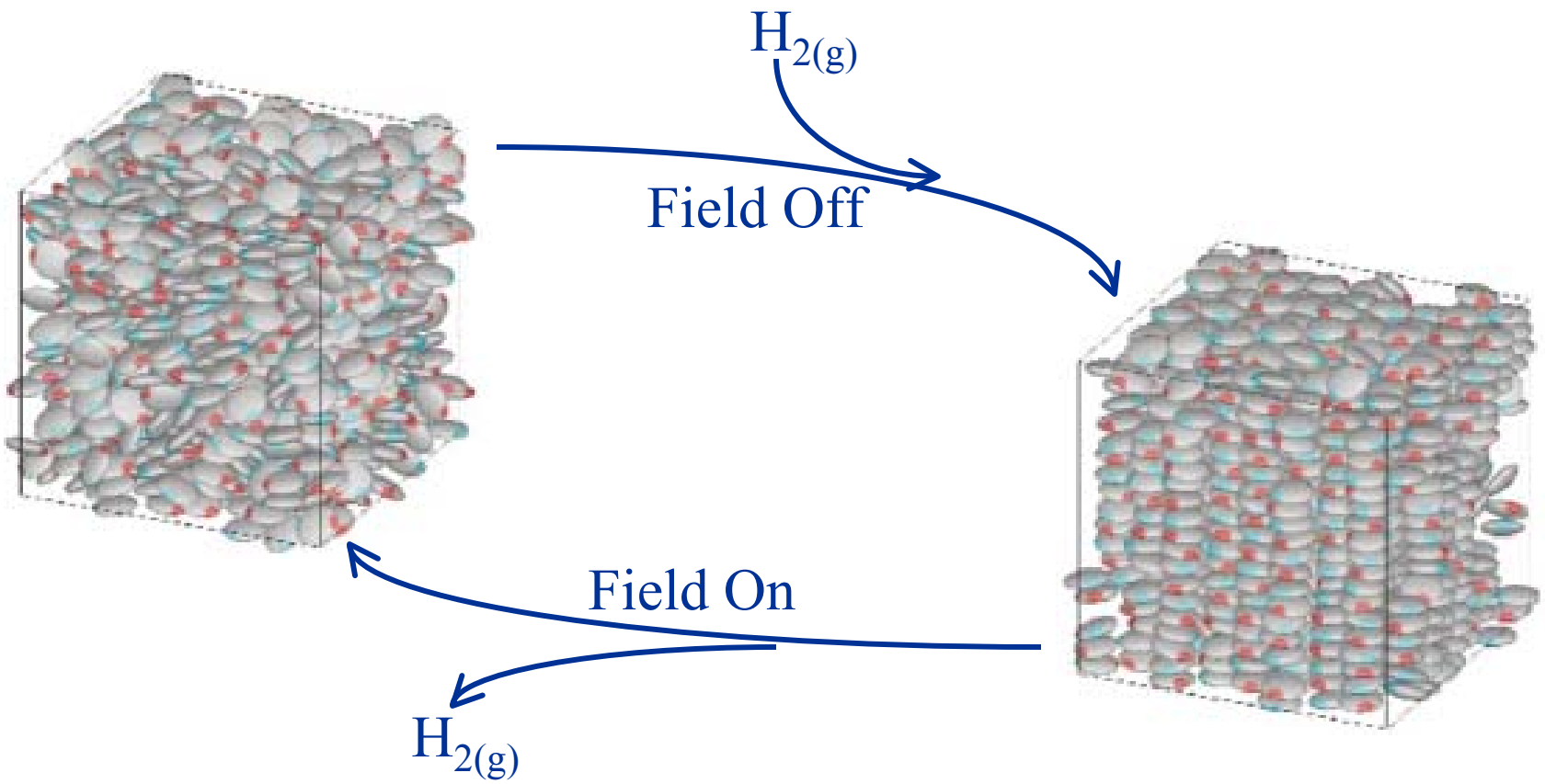
Future Plans

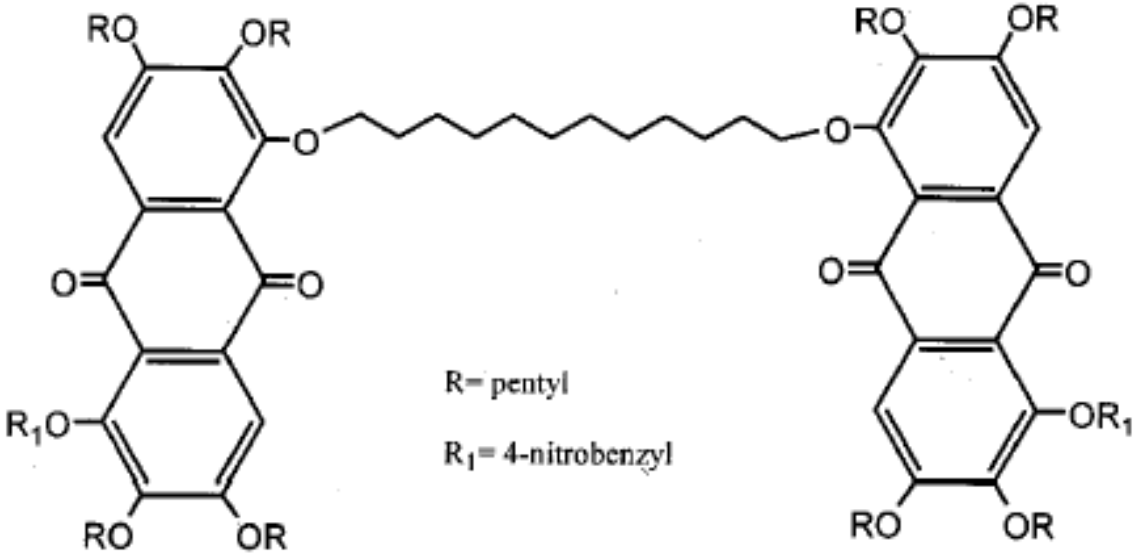
Current Project Continuation

- **Study effects of inclusion of other light elements, eg. Mg, into $LaNi_5$**
- **Develop forms of material that are efficient and easy to handle for hydrogen and helium separation and purification**
- **Work out reversibility of gas phase reaction**
- **Develop methods for reactivation of $LaNi_5$ after extended cycling**

New Direction

- **Develop new materials**
  - **Materials similar to MOF's but with real-time, externally controllable pore sizes**
  - **Will provide for efficient storage of hydrogen**
  - **Will allow non-thermal control of hydrogen uptake and release**


$H_{2(g)}$
Field Off
Field On
$H_{2(g)}$



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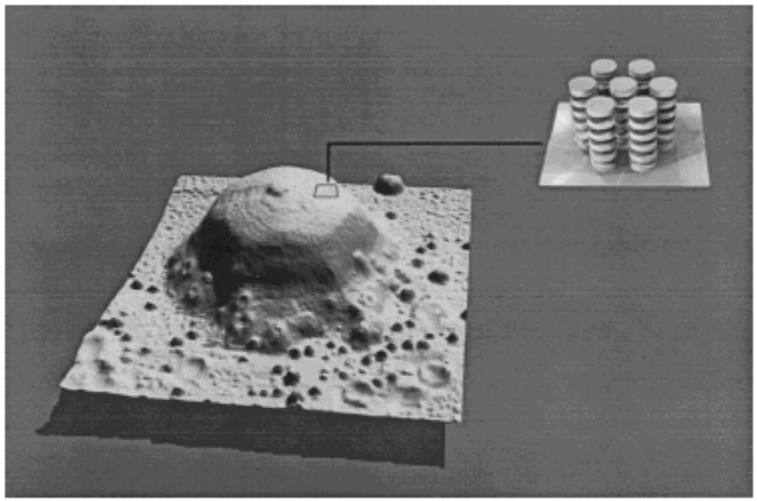


Fig. 1. AFM image of a hexagon and a scheme showing the orientation of the discotic columns.

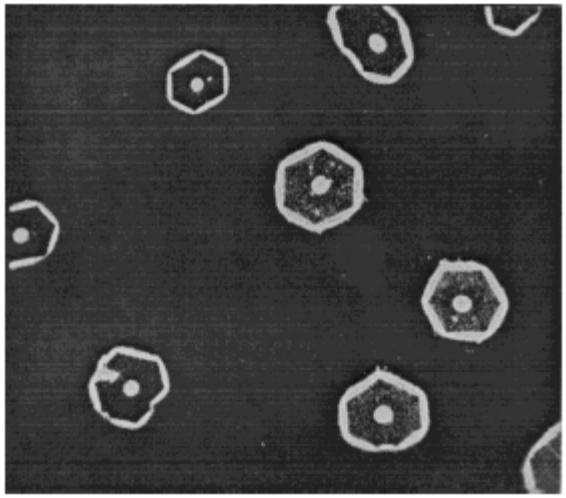
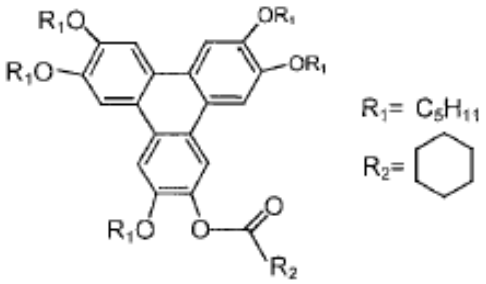


Fig. 2. Fluorescence microscopy image of several hexagons.



3,6,7,10,11-Pentapentyloxytriphenylene-2-yl-cyclohexanoate

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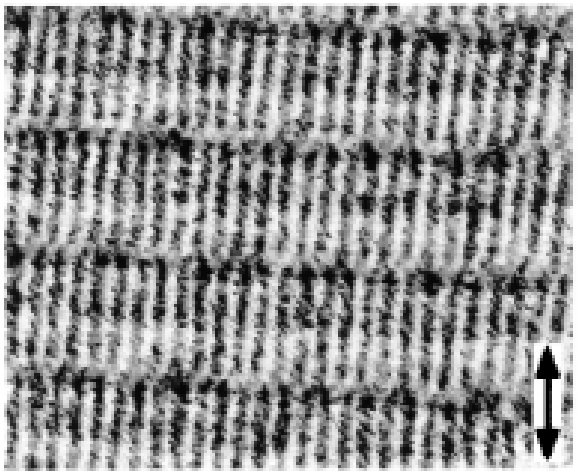

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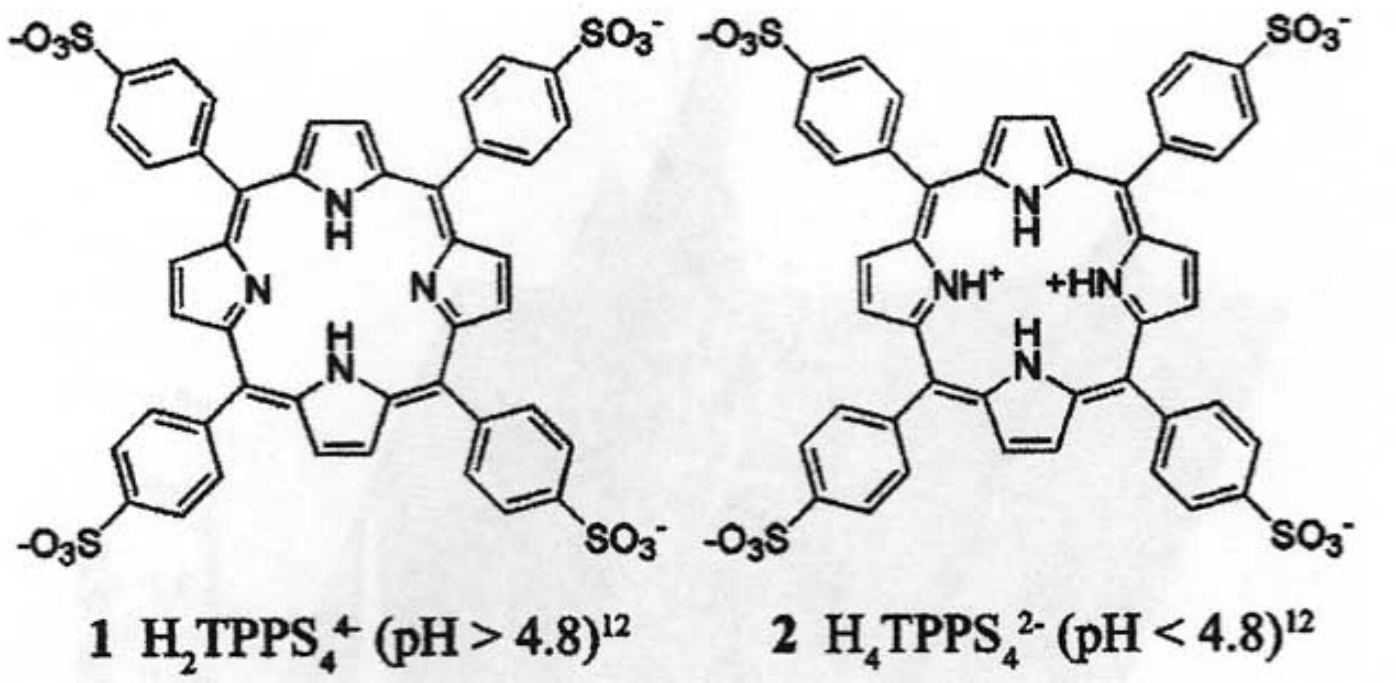

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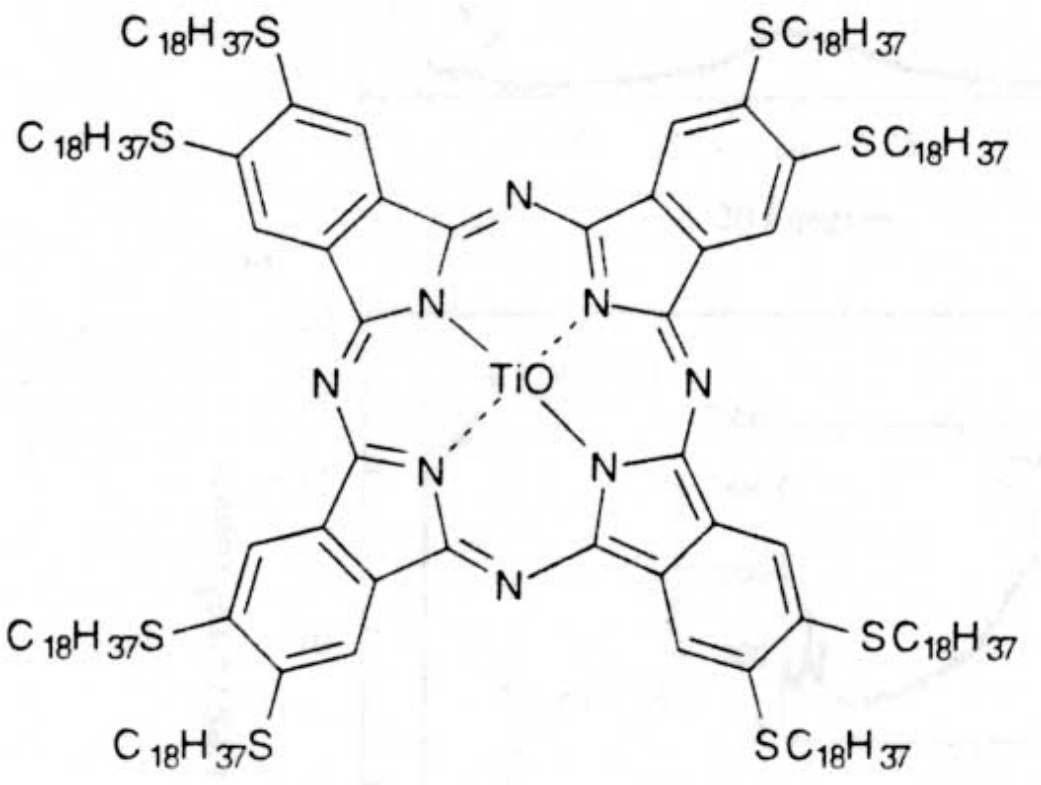

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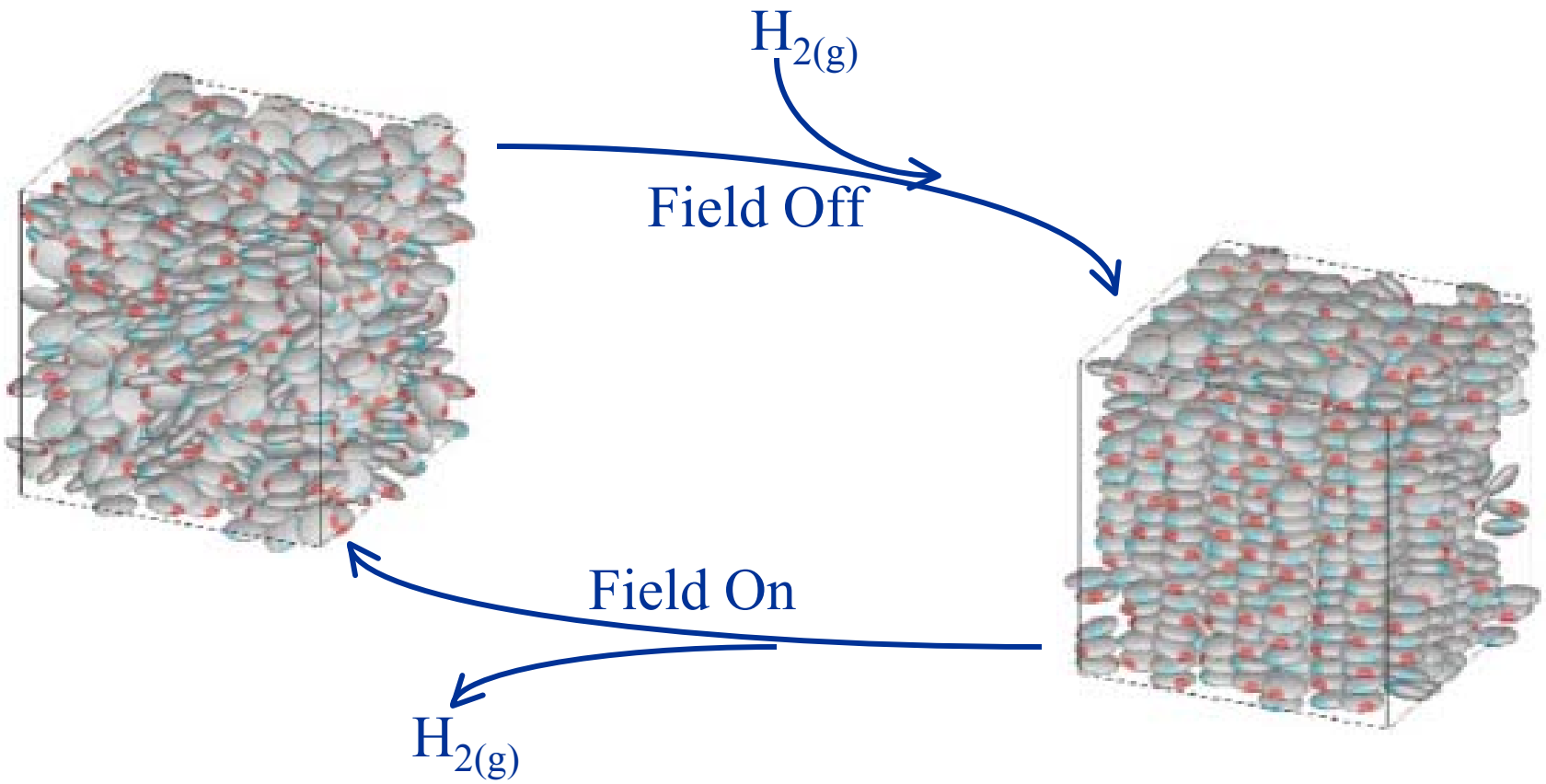
$H_{2(g)}$
Field Off
Field On
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