Chemical Hydrogen Storage

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Speakers: S. Suda, Y. Saito, A. Cooper, Y. Wu, K. Barral, T. Autrey, P. Prosini

12 Posters

Chemical Hydrogen Storage

- Liquid or solid fuel infrastructure may be possible
- A number of concepts have been demonstrated with high material hydrogen storage capacity
- Exothermic and endothermic catalyzed hydrogen generation reactions
- Regeneration is key
  - Off-board regeneration is likely
  - Energy efficiency
  - Recyclability of materials
  - Some processes may use hydrogen, others may not

Three Main Concepts Presented at Conference

- Sodium borohydride hydrolysis: $NaBH_4 + H_2O$
- Other boron compounds: H_3NBH_3
- Dehydrogenation of organics
  - Carbocyclic compounds (e.g. decalin = naphthalene)
  - Heteroatom-substituted systems (e.g. N-ethylcarbazole)
- Also, one poster on coordination complexes of NH_3

Sodium Borohydride Hydrolysis and Regeneration

- Exothermic hydrogen generation: catalysts and systems
  - H2 generation systems
    - Wu (Millennium Cell), Prof. Suda, Posters
  - Stability of Solutions
    - Barral (Air Liquide)
  - On-board system (Natrium)
    - Abdel-Baset (Daimler-Chrysler)

- Regeneration: B-O to B-H
  - Energy Efficiency
  - Economic analyses and cost estimates
    - Barral (Air Liquide), Prosini (ENEA)
  - Improved processes/cheaper reducing equivalents
    - Suda, Wu

Regeneration Efficiency: Pathways

Boron-Nitrogen Compounds

- Avoid formation of stable B-O bond
- High material hydrogen storage capacity (significant potential)
- Several hydrogen generation concepts advanced
- Mechanisms, catalysts, substitution
  - Autrey (PNNL), RTI, Los Alamos, Industrial Research Lab (NZ)
- Regeneration Pathways
  - Thermodynamics appear to be reasonable
  - May not be able to use H_2

(BNHx) Regeneration

Dehydrogenation of Organic Systems

- Endothermic hydrogen generation
  - Saito (Tokyo Univ of Science), Cooper (Air Products)
- Thermodynamics depends on structure
- Heteroatom substitution can favorably alter thermodynamics
  - Air Products, Los Alamos
- Catalyst development for dehydrogenation
  - Non-precious metal catalysts
  - Increased rates

Catalyst Development

Potential Areas for Collaboration-1

- Catalysis
  - Non-precious metals
  - Rates, heat management (endo/exothermic reactions)
- Coupling to Fuel Cell
  - Impurities and impurity tolerance (composition and quanitities)
  - Heat and materials balance
- Infrastructure
  - Energy and/or hydrogen source
  - Analysis
  - Off-board regeneration infrastructure

Potential Areas for Collaboration-2

- Mechanisms and Kinetics
  - Molecular systems, spectroscopy
  - Theory and computation for thermodynamics, reaction intermediates
- On-board reactor
  - Reactor engineering, control interaction of material with catalyst
  - Overall system engineering, materials compatibility
- Off-board regeneration
  - Energy efficiency
  - Reaction pathways
    - Rehydrogenation
    - Other reduction chemistries
  - Cheaper reducing equivalents