Update on US Activities

US-China Clean Energy Research Center
Clean Vehicles Consortium
(CERC-CVC)

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“The objective of CERC-CVC is to contribute to dramatic improvements in technologies with the potential to reduce the dependence of vehicles on oil and improve vehicle fuel efficiency” through the synergy of:

- **Vehicle electrification**
- **Novel energy storage materials**
- **Next-generation biofuels**
- **Lightweight structures**
- **Efficient energy conversion**

guided by a holistic life cycle design and optimization framework.
Academic and National Lab Partners

U.S.
- UNIVERSITY OF MICHIGAN
- THE OHIO STATE UNIVERSITY
- MIT
- Sandia National Laboratories
- OAK RIDGE National Laboratory
- Argonne National Laboratory
- jbei Joint BioEnergy Institute

China
- Tsinghua University
- Shanghai Jiao Tong University
- Beijing Institute of Technology
- Zhejiang University
- Dalian University of Technology
- Harbin Institute of Technology
- Beijing Institute of Petrochemical Technology
- Beijing Institute of Technology (Tianjin)
- University of Science and Technology of China
- Tsinghua University (Beijing)
- Peking University
- Beijing Normal University
- Chinese University of Geosciences
- Beijing Institute of Petrochemical Technology
- Tsinghua University (Chengdu)
Industrial Partners

U.S.

Ford  DELPHI  DENSO  EATON

China

TOYOTA  HONDA  pjm  TE  Aramco Services Company

SAIC  GEELY  JAC  CATARC  GM

LISTEN  Potevio  JJ  ECTEK  KeyPower
Thrust Areas

1. Advanced Batteries and Energy Conversion
2. Advanced Biofuels, Clean Combustion and APU
3. Vehicle Electrification
4. Lightweight Structures
5. Vehicle-Grid Integration
Battery Research Themes

1. Characterization of Degradation Mechanisms in Li-Ion Batteries
   • Multi-scale Characterization of bulk degradation mechanisms
   • Characterization of Solid Electrolyte Interfaces
   • Computational study of degradation mechanisms resulting from phase transformations

2. High Energy Density Battery Chemistries
   • Advanced Li-ion chemistries
   • Li-sulfur batteries
   • Metal-air batteries

3. Battery Implementation
   • Safety
   • Reuse & recycling
   • Testing protocols & standardization

4. Modeling and control of Battery Systems
   • Multi-scale modeling
   • Control strategies and health management
Plan (2013)

- Leverage ORNL prototyping facility:
  - Manufacture LMR-NMC prototype cells
  - Distribute cells for analysis to partners
- Develop *in situ* capability to bridge length scales and better understand real-time degradation
- Safety assessment of Li-rich and high voltage systems
- Analysis of recycling efficiency and chemical processes for commercial Li-ion cathode materials
- Develop understanding of promotion mechanisms arising from metal-oxides in metal-air batteries
- Age and analyze commercial LFP cells donated to CERC

Status (2014)

- First round of cells manufactured for *in-situ* neutron diffraction characterization
- OSU NDP analysis of real-time lithiation/delithiation kinetics in Sn anodes (*Angewandte Chemie*, 2014)
- THU analysis of thermal run-away & overcharging scenarios (L. Lu)
- BIT/ANL team analyzing chemical pathways and life-cycle efficiency (L. Li)
- Examined Na-air systems, which show promise for efficient charging. Explored mechanisms for nucleation and transport within discharge phase
- OSU using AFM and EELS to characterize LFP cells donated to CERC
Manufacturing of Pouch Cells for Battery Degradation Studies

Scientific Achievement
Manufacturing custom large format pouch cells with consistent performance for in-situ neutron diffraction studies

Significance and Impact
- Knowledge about components, their composition and cell processing methods will enable CERC partners to more quantitatively analyze battery performance
- Considerably improve our understanding of degradation mechanisms in electrodes aged in large format cells under realistic conditions
- Flexibility in cell design will aid researchers in developing new experimental techniques

Future Plans
- Manufacture and age cells for material characterization and degradation studies to see effect of different parameters such as inhomogeneities, formation cycle current, areal solid loading gradient and aqueous processing

Work performed at Oak Ridge National Lab