OVERVIEW OF ENERGY STORAGE PROGRAM AT THE PACIFIC NORTHWEST NATIONAL LABORATORIES

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Funded by the Energy Storage Systems Program of the U.S. Department Of Energy through Pacific Northwest National Laboratories

Pacific Northwest
NATIONAL LABORATORY

Transformational Materials Science Initiative

Launched the $15M Transformational Materials Science Initiative at PNNL to address the materials science challenges for energy storage in 2007.

Core capabilities:

- Controlled synthesis/assembly of complex materials
- In-situ measurement and characterization and modeling

Focus areas:

- Energy storage
- Energy conversion

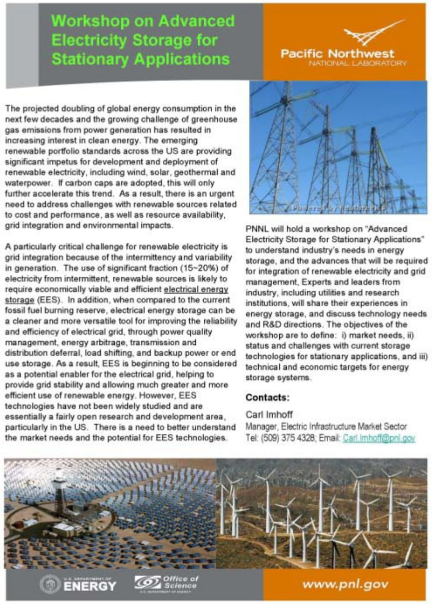
Conducted a PNNL workshop on the research needs for stationary energy storage;

Initiated nanostructured electrode materials research for Li-ion batteries;

Initiated proof-of-concept work for planar Na-beta batteries;

Started to explore the fundamental chemistry in redox flow batteries;

Supported the initial development of the method for grid analysis.



Workshop on Advanced Electricity Storage for Stationary Applications

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The projected doubling of global energy consumption in the next few decades and the growing challenge of greenhouse gas emissions from power generation has resulted in increasing interest in clean energy. The emerging renewable portfolio standards across the US are providing significant impetus for development and deployment of renewable electricity, including wind, solar, geothermal and waterpower. If carbon caps are adopted, this will only further accelerate this trend. As a result, there is an urgent need to address challenges with renewable sources related to cost and performance, as well as resource availability, grid integration and environmental impacts.

A particularly critical challenge for renewable electricity is grid integration because of the intermittency and variability in generation. The use of significant fraction (15~20%) of electricity from intermittent, renewable sources is likely to require economically viable and efficient electrical energy storage (EES). In addition, when compared to the current fossil fuel burning reserve, electrical energy storage can be a cleaner and more versatile tool for improving the reliability and efficiency of electrical grid, through power quality management, energy arbitrage, transmission and distribution deferral, load shifting, and backup power or end use storage. As a result, EES is beginning to be considered as a potential enabler for the electrical grid, helping to provide grid stability and allowing much greater and more efficient use of renewable energy. However, EES technologies have not been widely studied and are essentially a fairly open research and development area, particularly in the US. There is a need to better understand the market needs and the potential for EES technologies.

PNNL will hold a workshop on "Advanced Electricity Storage for Stationary Applications" to understand industry's needs in energy storage, and the advances that will be required for integration of renewable electricity and grid management, Experts and leaders from industry, including utilities and research institutions, will share their experiences in energy storage, and discuss technology needs and R&D directions. The objectives of the workshop are to define: i) market needs, ii) status and challenges with current storage technologies for stationary applications, and iii) technical and economic targets for energy storage systems.

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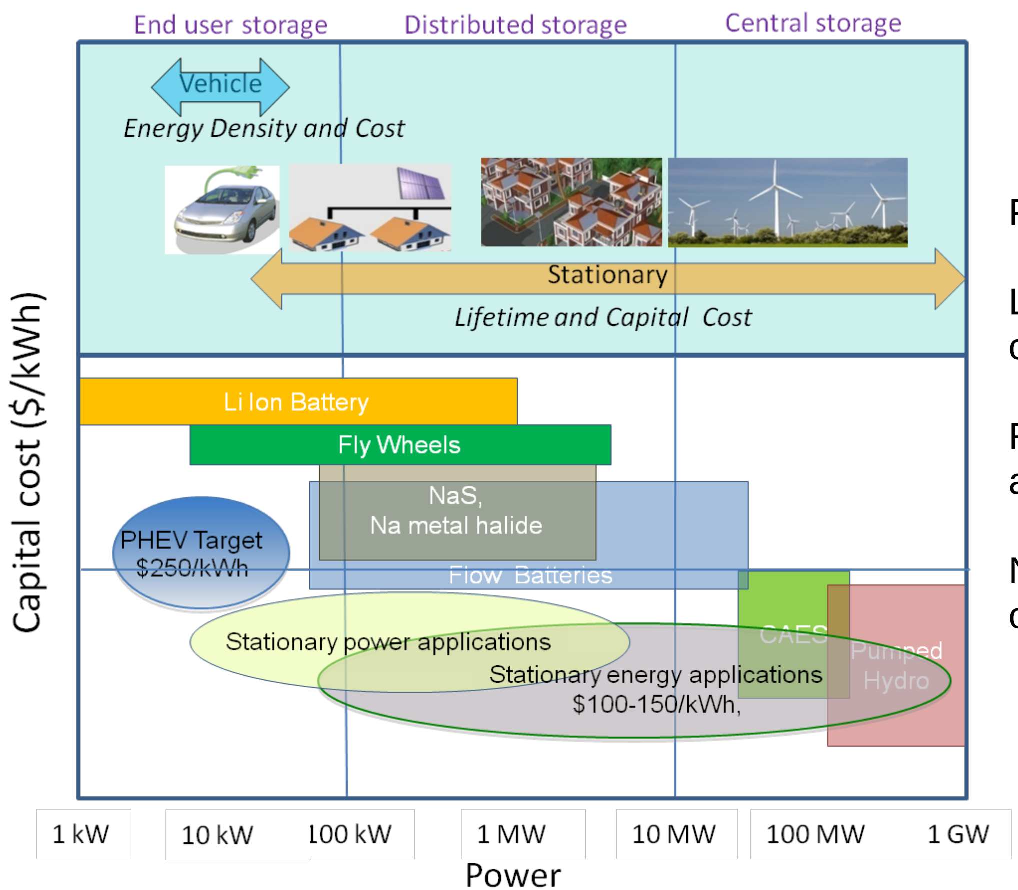
Current Research focus areas

Economic and performance requirement for different applications

Materials and technology challenges

Current and emerging technologies for storage

Different technologies will have different applications. There will not be a single answer for the storage problem.



PNNL is working on three key technologies:

Li-ion battery: inexpensive materials and safe chemistry;

Redox flow battery: increase energy density and electrolyte stability;

Na-beta battery: improve safety reduce operating temperature.

Addressing Fundamental Challenges for Large Scale Energy Storage

Tools and methodologies to predict and analyze the economics of specific technologies for different scales/different applications and guide smart grid integration;

Fundamental understand of the materials properties and chemical processes in complex, reactive environments and systems;

New materials, chemistry and components to significantly improve the efficiency, reliability, safety and life span of current and future storage systems;

Revolutionary designs, concepts and architectures that can significantly reduce the system and maintenance cost of large energy storage systems;

Novel energy storage mechanisms, energy storage technologies that are environmentally friendly and that are not dependent on materials and chemicals of limited supply.

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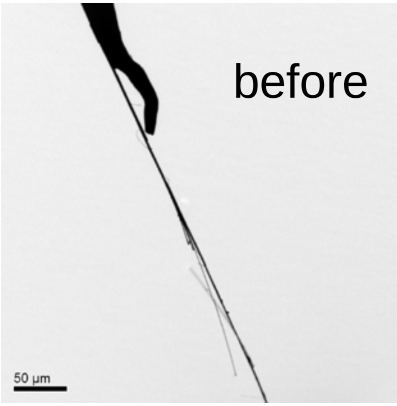
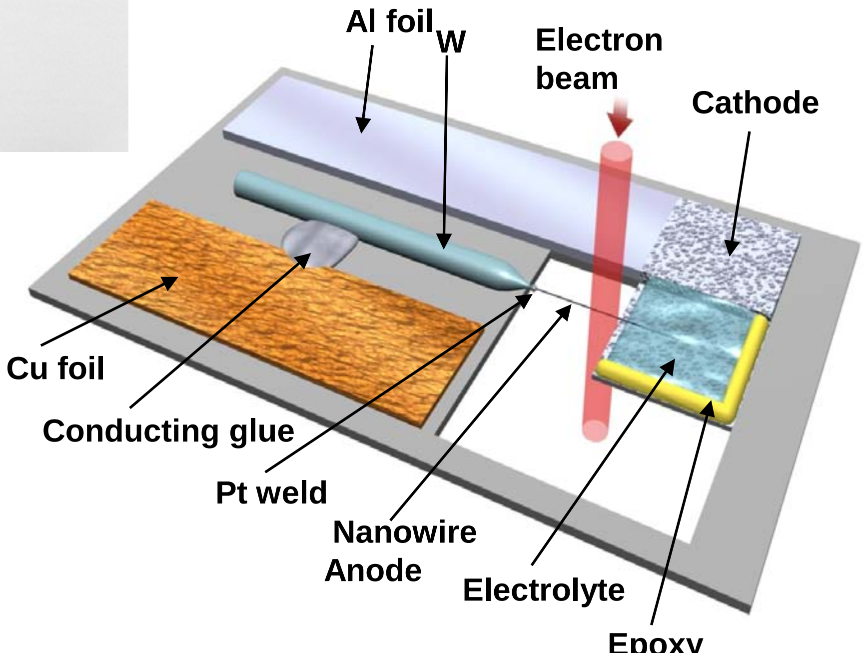
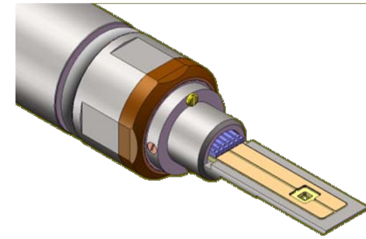
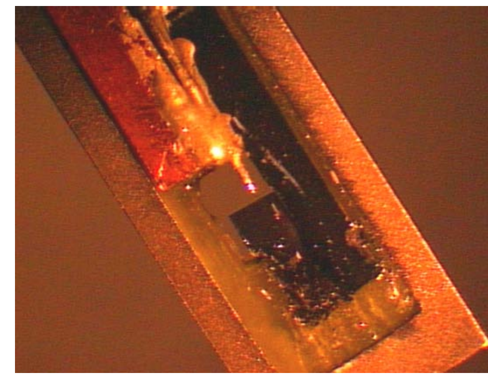
In-situ TEM and advanced high field NMR techniques for characetrization









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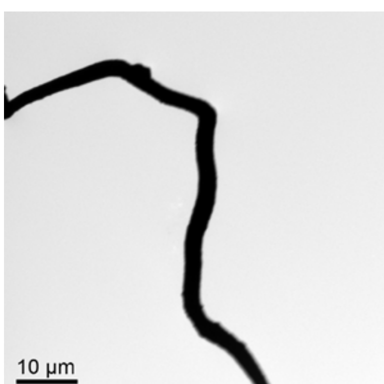
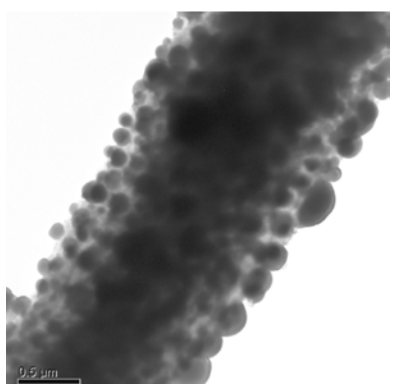
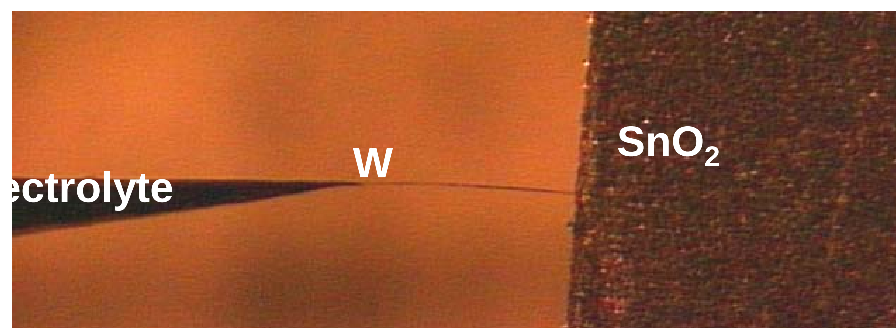


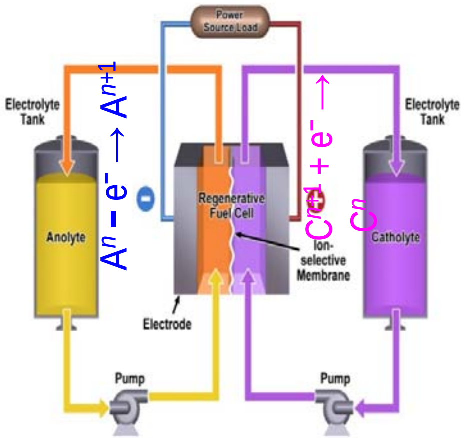


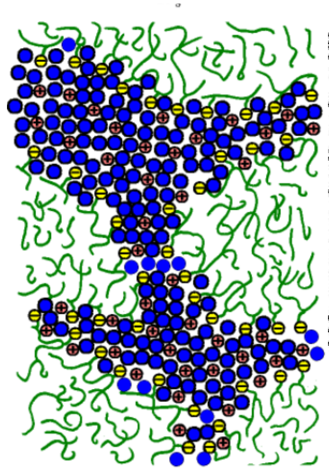


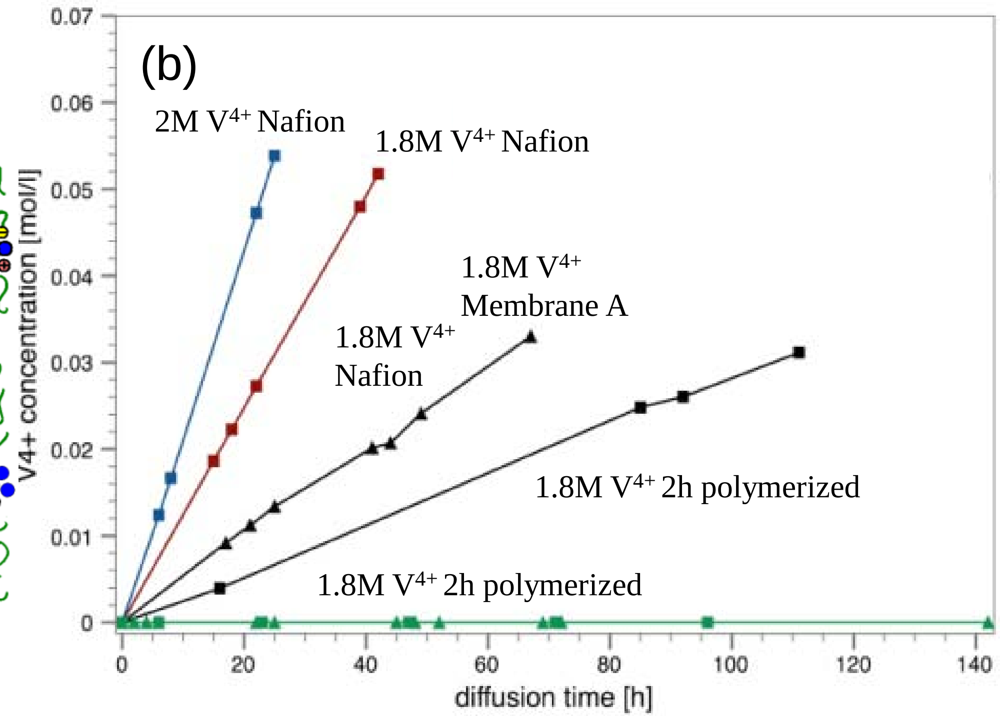
C. Wang et al, Nano Lett, in revision

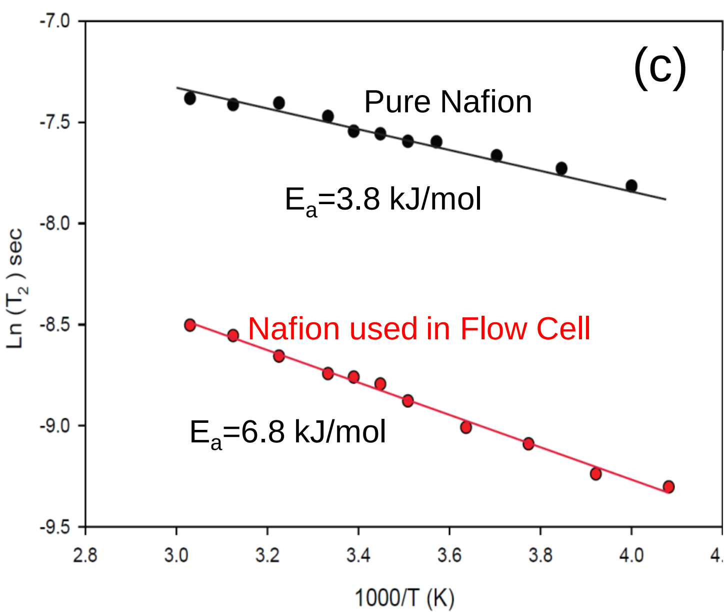
Separators and membranes are widely used, but suffer cross-contamination and fouling.

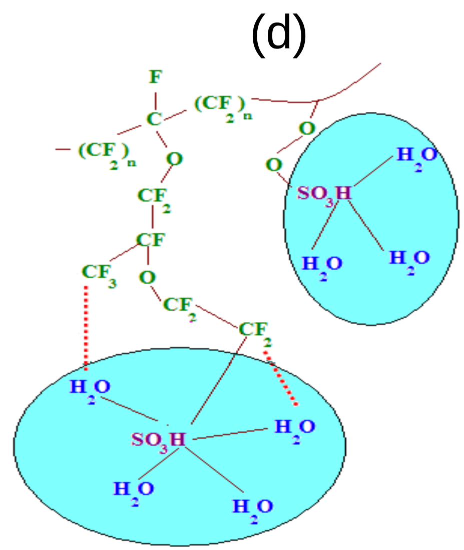
Schematic of Nafion membrane

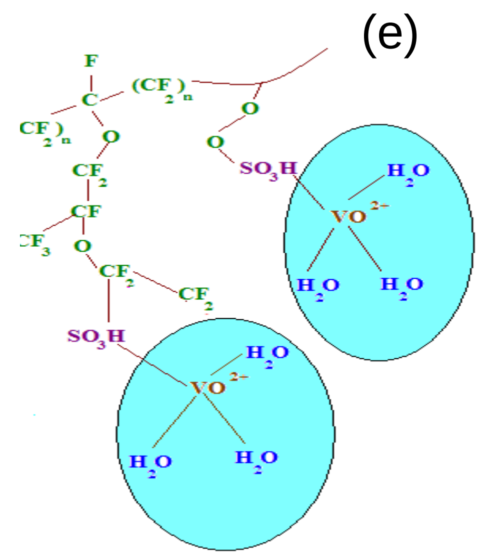




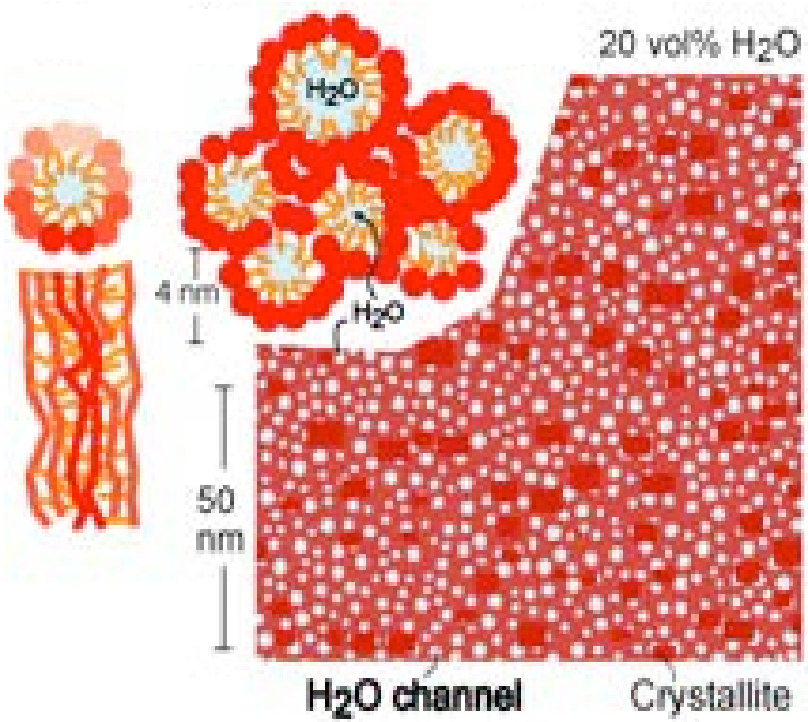


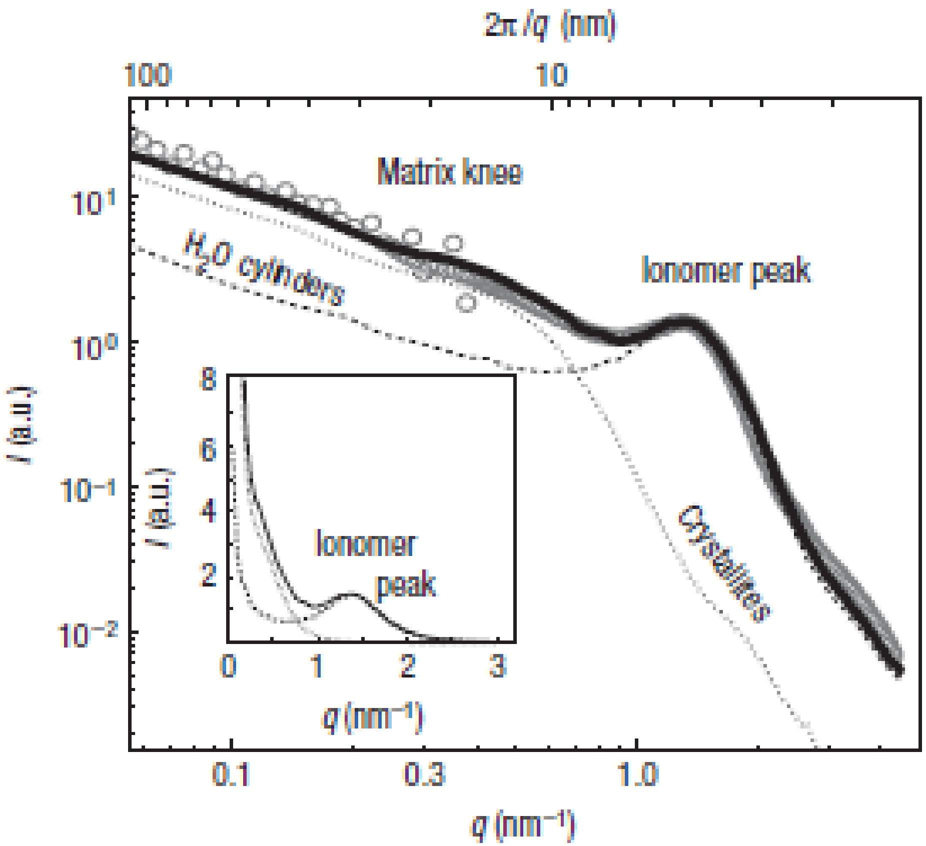






New understanding of Nafion membranes: wide pore channels (2.4 nm), suggesting the importance of water diffusion for H conducting. Such water diffusion mechanism will also favor the diffusion of hydrated cations.





K. Schmidt-Rohr, Q. Chen, *Nature Materials* ***2008, 7, 75.***

Integrated Energy Storage Team at PNNL

Transformational Materials Science Initiative


Jun Liu


Carl Imhoff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Transportation Storage: Li-ion, Li-S, Li-Air


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Cross-cutting capabilities

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Kevin Rosso

In-situ TEM and NMR


Jianzhi Hu


Chongmin Wang

Grid analysis


Michael Kintner-Meyer

Electrical infrastructure operation center


Carl Imhoff

Stationary Technology Development

Redox flow batteries


Gary Yang


Liyu Li

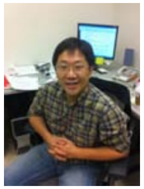
Planar Na-beta batteries


John Lemmon


Vincent Sprenkle


Gary Yang

Stationary Li-ion batteries


Wei Wang


Daiwon Choi

Low T Na batteries


Yuliang Cao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