

Battery Technologies Available for Licensing

[Fail Safe Design for Large Capacity Li-Ion Battery Systems](#)

Issued Patent 9,341,678

This lithium-ion battery design for large capacity systems developed by NREL scientists improves battery safety and prevents thermal runaway by separating the current and electrical pathways to allow for early detection of an internal short circuit. This system isolates the detected fault electrically to significantly improve the safety of lithium-ion battery systems.

[Internal Short Circuit Device for Improved Lithium-Ion Battery Design](#)

Issued Patent 9,142,829 and European Patent Application 2633585

This award winning internal short circuit device developed by NREL and NASA scientists significantly improves the safety within both spirally wound and flat-plate lithium-ion electrochemical systems. This device is shorted by electrically connecting the anode and cathode once a predetermined temperature is achieved, does not rely on mechanically deforming the battery to activate a short, and can be placed anywhere within the cell.

[Nanotube Arrays for Advanced Lithium-ion Batteries](#)

Issued Patent 8,389,157

This novel electrode structure developed by NREL scientists consists of nanotube arrays that are aligned perpendicularly to the current collecting substrate through a low-cost electrochemical anodization technique. These innovative and low cost nanotube arrays increase the charge rate, cycle count, and overall energy density of lithium-ion batteries.

[Hybrid Radical Energy Storage Device](#)

Issued Patents 8,940,444 and 9,324,992

Organic radical batteries are a relatively new class of rechargeable batteries that are based on the utilization of stable organic radical molecular/polymer compounds as the cathode electrode within a high performance battery. A team of NREL scientists have developed an organic radical based battery that has achieved a higher performance level than any other organic radical batteries when compared to common carbon based anodes. This non-flammable hybrid radical energy storage device combines a hybrid radical cathode with a carbon nanotube radical anode to allow for an approximate 2.8 – 3.5 V cell to deliver an energy density of 560-800 Whr/kg without incorporating a lithium metal oxide component.

[New Electrode Materials for Magnesium Batteries and Metal Anodes](#)

Patent Applications 2015-0295292 and PCT/US16/38793

Scientists at NREL have developed novel electrode materials for magnesium (Mg) batteries and metal anodes that increase energy storage capacity, safety, and stability. One novel material developed is an MgB₂ anode that allows for the use of non-aqueous electrolytes within an Mg battery, resulting in a greater energy density than current lithium-ion technology. Additionally, scientists at NREL have invented a conductive coating layer for Mg metal anodes to prevent direct contact between Mg and the cells' electrolyte. This conductive coating can work with various aprotic electrolytes and previously excluded high-voltage cathodes, revolutionizing the field of Mg metal anode batteries.

[Device and Software to Measure Thermal Impedance of Electrochemical Systems](#)

Patent Application 14/855,538

Developed by NREL engineers, this device and software carefully measures and monitors the thermal impedance and voltage profile of an electrochemical system under various load conditions. This cost reducing device helps attribute degradation in the systems' performance to individual components and increases safety, reliability, and battery life.

[Balancing and Control System for Operation of Multiple Cells and Packs in Large Energy Storage Arrays](#)

Patent Applications 2015-0214757, 15/224,123, and 15/224,275

Developed by NREL scientists and other research collaborators, this low-cost active balancing system for large arrays of multi-cell and multi-pack storage systems allows for partial pack functionality with the presence of a failed cell. This optimally designed system balances power and energy density through utilizing a shared bus to connect cells and packs, serves as a control reference, and enables communication amongst the cells and packs.

Contact Information

For more information or for licensing opportunities, please contact Erin Beaumont, Licensing Executive, National Renewable Energy Laboratory, at (303) 275-4353 or Erin.Beaumont@nrel.gov

National Renewable Energy Laboratory

15013 Denver West Parkway • Golden, CO 80401
303-275-3000 • www.nrel.gov

NREL/FS-7A10-67336 • December 2016

NREL prints on paper that contains recycled content.