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CHANGING WHAT'S POSSIBLE

CIRCULAR—Catalyzing Innovative Research for Circular Use of Long-lived Advanced Rechargeables

PROJECT DESCRIPTIONS

HighT-Tech –College Park, MD

Rapid Surface Graphitization of Carbon Anode for In Situ Regeneration of Batteries - $1,368,459

HighT-Tech will develop ultrathin and compact protective coating material for the surface of graphite using ultrafast high-temperature sintering. This approach will enable the implementation of simple and programmed protocols to increase the longevity of lithium-ion batteries containing graphite anodes. The research could lengthen the lifetime of lithium iron phosphate/graphite batteries, which have promising characteristics for use in electric vehicles, backup power, and utility-scale energy storage.

OnTo Technology – Bend, OR

Rejuvenation to Increase Life of Advanced Batteries - $3,565,804

OnTo Technology and its partners will develop battery rejuvenation techniques for battery cells with different shape factors to simultaneously double the lifetime and reduce the cost of energy delivered. Battery rejuvenation is a process that involves sequentially removing electrolyte, cleansing electrodes, and replenishing the electrolyte. Cell design will need to be modified to facilitate the rejuvenation process. Unique features of the technology developed in the project include flexibility in terms of battery chemistry and potential for low capital and operating costs.

University of Colorado Boulder – Boulder, CO

Robust Robotic Disassembly of EV Battery Packs using Open-World Vision Language Models and Symbolic Replanning - $1,800,024

The University of Colorado Boulder will develop techniques for autonomous disassembly of electric vehicle (EV) lithium-ion batteries. The team's disassembly pipeline consists of humanoid robots, collaborative robotic arms, and heavy-duty industrial arms working in concert. In this project, the humanoid robots will work together with robot arms to manipulate wire harnesses and remove screws and other components before dismantling several commercial battery packs with a heavy-duty industrial arm. State-of-the-art perception models boosted by large-language models to consider physics and context of a scene will be employed. Techniques that allow robots to learn disassembly steps and the appearance of relevant parts from language instructions will also be investigated.

Saint-Gobain Ceramics & Plastics, Inc. – Northboro, MA

EV battERy lifetiMe extensiOn with mateRial intelligencE (EVERMORE) - $3,677,038

Saint-Gobain Ceramics & Plastics, Inc. will develop electric vehicle (EV) Battery Lifetime Extension with Material Intelligence (EVERMORE) targeting to improve the life span of batteries by greater than 100% and reduce greenhouse gas emissions per energy unit delivered by 50%. EVERMORE emphasizes the utilization of a tri-functional material, which simultaneously provides balanced mechanical management, thermal management, and thermal runaway safety protection.

BMW – Mountain View, CA

Electric Vehicle Battery Pack Designed for Disassembly - $4,499,089

BMW will develop an electric vehicle (EV) battery pack that, while retaining the mechanical stability and energy density of state-of-the-art packs, is designed for rapid, robotic disassembly. Rapid disassembly will enable re-work of parts that were scrapped during manufacturing, repair of packs damaged during use in the vehicle, and second-life applications that extend the useful life of the pack after its first life in the vehicle.

University of Michigan – Ann Arbor, MI

Rapid State of Health Diagnosis by Model-Enabled Pulse Form Sequence - $2,680,000

The University of Michigan will develop an approach that integrates physics-based modeling and machine learning to rapidly and accurately determine the state of health and remaining useful life of battery cells. This technology allows for gauging the residual value of cells, which is essential for minimizing waste and promoting reuse and recycling. It also enables proactive maintenance strategies, optimization of battery charging and discharging protocols, extended cell life, operational efficiency, and improved safety.

Purdue University – West Lafayette, IN

Integrated Technoeconomic, Lifecycle, and Circularity Analyses Tool for EV Batteries - $2,500,000

The team led by Purdue University will develop a first-of-its-kind, integrated software tool capable of analyzing the economic, environmental, and circularity performance of innovative technologies developed by other CIRCULAR teams to achieve a circular electric vehicle battery supply chain. The project brings together complementary expertise in the areas of technoeconomic analysis, life cycle assessment, circularity analysis, battery technologies, and critical material recycling. The tool is envisioned to be an open-source desktop application based on the high-level programming language Python, with an intuitive graphical user interface.

University of Michigan – Ann Arbor, MI

Multi-Material Direct Joining and Un-Joining for Easy EV Battery Pack Assembly and Disassembly for Maximal Circularity - $2,540,027

The University of Michigan and its collaborators will develop a multi-material and lightweight design for achieving easy assembly and reversible manufacturing of electric vehicle (EV) battery from cell to modules/packs. To accomplish this, the project will focus on direct joining techniques for dissimilar materials, such as direct welding of polymer composites to metals. Advanced bi-material interface mechanics modeling will be considered for developing effective un-joining techniques for facilitating easy re-joining. The proposed approach would also provide an innovative multi-material EV battery module and pack designs for achieving maximal circularity while ensuring structural integrity and operational safety.

University of California San Diego – La Jolla, CA

Regenerable Lithium-Ion Batteries with High Energy and Long Life - $2,520,000

The University of California San Diego (UCSD) will develop a comprehensive and integrated strategy for practical in situ regeneration of spent lithium-ion batteries. Rather than relying on current day energy-intensive recycling methods, UCSD will design new technologies to prolong the life and restore the electrical energy storage capacity of electric vehicle (EV) batteries. UCSD's approach includes developing recovery reagents, optimizing electrode architectures and surface coatings, designing new cell configurations, and integrating operando diagnostic metrology.

Iontra – Centennial, CO

Sensing Platform for Fast Cell-Agnostic Battery State Diagnostics - $2,150,000

Iontra will transform its proprietary method of sensing the condition of lithium-ion batteries into an advanced diagnostics system for larger electric vehicle (EV) batteries. To achieve this, the existing system will be tested and refined against EV batteries of gradually increasing size and complexity from cells to modules to packs. Development will be aided by state-of-the-art computational modeling combined with comprehensive analysis of tested cells. The system will significantly reduce the facilities, energy, and time needed (from hours to seconds) to obtain actionable battery state information including their state of health and remaining useful life.

Toyota Motor Engineering & Manufacturing North America, Inc. (TEMA) – Ann Arbor, MI

Development of an Autonomous Robotic Disassembly Process for Applications in Battery Pack Circularity - $4,502,196

TEMA aims to develop an industry-relevant template for a reduce, reuse, recycle (3R) facility of the future in hopes of resolving the primary bottlenecks in current battery supply chain circularity. This project will include the development of (1) an automated pack disassembly process, (2) advanced diagnostic tools and protocols for module and cell 3R classifications, and (3) a refabrication method for 3R cells into new energy systems. Together, these innovations will enable a scenario where end-of-life lithium-ion batteries are systematically evaluated, classified, and reused prior to being considered for recycling.

SeaLion Energy – Pittsburgh, PA

TARDIS-J: Tunable Activation & Regeneration in Devices using In-Situ Jamming - $1,623,752

SeaLion Energy will develop a low-cost and low-greenhouse gas coating technology that significantly extends battery cycle life. The nanoscale polymer coatings protect electrode particles from electrolyte reactions and particle cracking. In addition, the technology can dynamically activate through heating, regenerating degraded cells by repairing cracked particles. Key advantages include compatibility with multiple battery chemistries, minimal additional material use, and application via a scalable process used in semiconductor manufacturing.

Sonocharge Energy –San Diego, CA

Acoustic-Driven Rejuvenation of Rechargeable Batteries - $2,500,000

Sonocharge will design and apply surface acoustic wave technology to extend the service life of battery cells. Sonocharge and its partners will also develop methods to rejuvenate cells by restoring electrolytes and lithium inventory enhanced by surface acoustic wave technology. This project provides a rapid and non-destructive means of prolonging life and enhancing battery performance while preserving cell manufacturing value. The project represents a significant departure from traditional recycling methods, which are energy-intensive, emit high levels of greenhouse gases, and generate substantial waste.