National Aeronautics and Space Administration

NASA

TECHNOLOGY SOLUTION

Power Generation and Storage

Solid-State Lithium-Sulfur Battery Tech Portfolio

New battery paradigm for energy density, power, reliability and safety

SABERS, as this portfolio of innovations is named, refers to Solid-state Architecture Batteries for Enhanced Rechargeability and Safety. Developed jointly at NASA's Glenn, Langley and Ames Research Centers, SABERS includes several advanced material, manufacturing and computational design innovations that enable a new paradigm in battery performance. The primary target application is next-generation electric aviation propulsion systems, yet SABERS will benefit other applications, too. Whether for large electric vehicle systems or small electronic devices, SABERS can potentially set new benchmarks in energy density and power, all while offering the utmost in safety and reliability. And importantly, the inventors intentionally designed environmentally friendly and sustainable materials and manufacturing methods into SABERS' portfolio. SABERS can help address today and tomorrow's needs for electrification and sustainability.

NASA is seeking industry partners for commercialization. SABERS is available for license as a complete portfolio or as individual component technologies.

BENEFITS

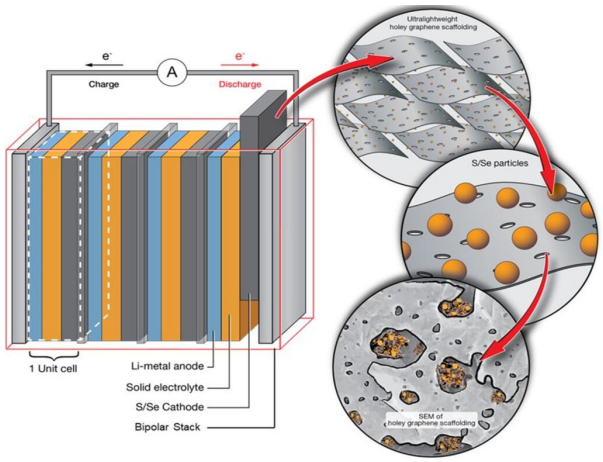
- Novel Battery Chemistry and Design: Lithium-Sulfur/Selenium with a solid-state electrolyte, enabled by graphene cathode and bipolar plate technology.
- High Performance: Energy density more than double current generation Li-Ion batteries. High discharge rates to power aircraft takeoff. Lightweight and robust.
- Safety: Solid-state design provides high damage tolerance and eliminates fire risks.
- Sustainability: The battery itself can enable electrification to help meet carbon emission climate goals and is amenable to recycling. Battery materials and manufacturing processes are environmentally friendly.
- Scalability: Based on readily scaled manufacturing processes.
- Patented: Several issued patents and pending patents. Additional patents anticipated.
- Suite of Technologies: This is not just one innovation, but an entire suite of innovations optimized in combination to meet performance goals. Based on the collective efforts of innovators at multiple NASA research centers.
- Prototype Demonstration: Coin-cell and pouch type batteries have been successfully demonstrated, and research is still on-going to optimize the design and performance.

THE TECHNOLOGY

The SABERS innovators developed novel lithium-sulfur designs, including sulfur-selenium on graphene cathodes, and lightweight bipolar plate stacking and packaging designs. SABERS is unique in several aspects: it deploys graphene-based manufacturing processes for the cathode and bipolar plates, and it uses a solid-state electrolyte in place of the liquid electrolyte found in other lithium-sulfur battery designs. The team has achieved energy densities over 500 W-hr/kg, and further improvements are expected. SABERS can meet the high-power requirements needed for aircraft take-off. SABERS is lightweight, safe, robust, and reliable. Furthermore, its manufacturing processes are scalable and environmentally friendly. Coin cell and pouch prototypes have been demonstrated to date. Development efforts continue and new portfolio innovations are expected. Major component technologies in SABERS include the following (as listed here and shown in the figure below).

- S/Se Cathode – Sulfur/Selenium on graphene scaffold (LAR-19556-1, LEW-20228-1)
- Solid Electrolyte – Solid-state electrolyte composites (LEW-20445-1)
- Bipolar Stack – Graphene plates (LAR-20257-1)
- Li-Metal Anode (Proprietary, under development)
- Packaging (Proprietary, under development)

Robust computational models have been developed to support the battery materials design and are available to licensees to evaluate and optimize different materials combinations and performance targets.



The SABERS Transformative Battery Technology Portfolio combines unique materials and processes to achieve performance goals.

APPLICATIONS

The technology has several potential applications:

- Aviation: Battery-powered propulsion systems for next generation electric aircraft
- Automotive: Lightweight batteries that can offer improved safety, sustainability and driving range of electric cars and trucks.
- Other: Military/Defense, Electronics, etc.

PUBLICATIONS

US Patents 9,120,677, 9,567,225, 10,836,137, and 11,413,850
Patents Pending

Dry Pressing Neat Active Materials into Ultrahigh Mass Loading Sandwich Cathodes Enabled by Holey Graphene Scaffold, https://pubs.acs.org/doi/full/10.1021/acsaem.0c00582

Holey Graphene–Enabled Solvent-Free Preparation of Ultrahigh Mass Loading Selenium Cathodes for High Areal Capacity Lithium–Selenium Batteries, https://www.frontiersin.org/articles/10.3389/fenrg.2021.703676/full

Practical considerations in designing solid state Li-S cells for electric aviation, https://www.sciencedirect.com/science/article/abs/pii/S0013468621016960

Li-Ion Permeability of Holey Graphene in Solid State Batteries: A Particle Dynamics Study, https://pubs.acs.org/doi/full/10.1021/acsami.2c03012

Relevant NTR numbers and information sheets for the SABERS suite of technology include:

LAR-19556-1
LEW-20228-1
LAR-18334-1
LEW-20445-1
LAR-20257-1
LAR-188671-1
LAR-188671-2
LAR-TOPS-302 (Graphene-based Manufacturing)
LAR-TOPS-165 (Other Graphene-based Manufacturing)

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NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

LEW-20228-1, LEW-20445-1, LEW-TOPS-167

More Information

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