Solid-state Architecture Batteries for Enhanced Rechargeability and Safety (SABERS)

Beyond Li-Ion: Technology to Enable Sustainable Electric Aviation

National Aeronautics and Space Administration

Challenge

- Electric aviation is a revolutionary leap in sustainable aviation
- Current battery technology does not meet the strict aerospace performance and safety metrics
- Can we exceed 400 Wh/kg in specific energy and operate safely at a rate of 1C and beyond?

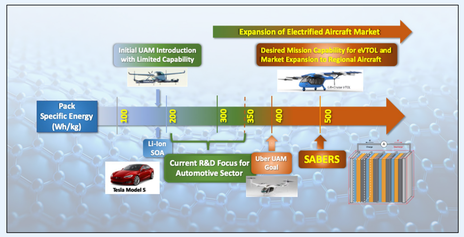
Solution

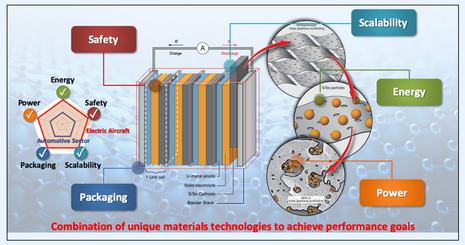
- Develop a solid-state bipolar battery stack based on novel Li-S/Se chemistry and a non-flammable electrolyte to produce a battery that enables sustainable electric aviation
- Design SABERS cells to exceed 500 Wh/kg, operate up to 150 oC, are 1 to 4C capable, and inherently non-flammable
- Satisfy system level needs such as non-flammability, energy density, discharge rate, packaging, and scalability

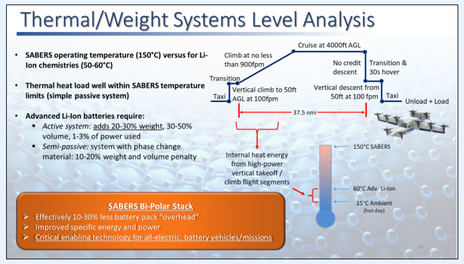
Expected Impacts

- Expand the missions served by electric aviation with a safe battery with twice specific energy over current SOA Li-ion batteries
- Reduce waste in the environment through recyclability: recovering solid lithium and sulfur components, and reprocessing the electrolyte
- Reduce waste in the environment by using a waste byproduct of oil refining, Sulfur - the active component in SABERS cells

Motivation and Solution

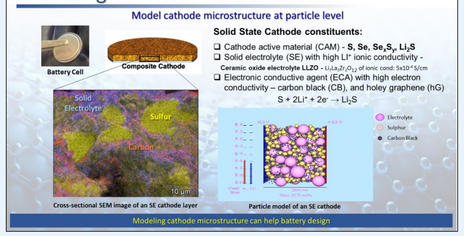


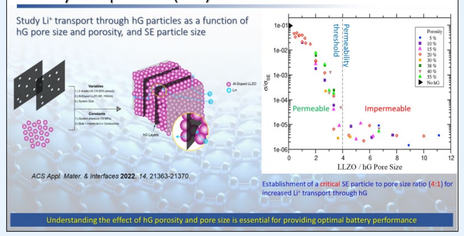


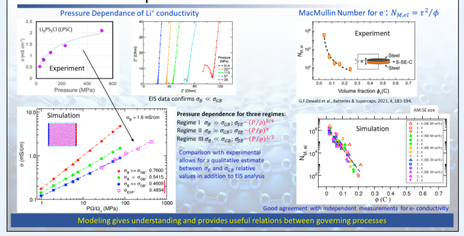


a) Specific energy targets b) SABERS concept to meet aerospace requirements c) Systems level benefits of typical eVTOL mission

Computational Modeling

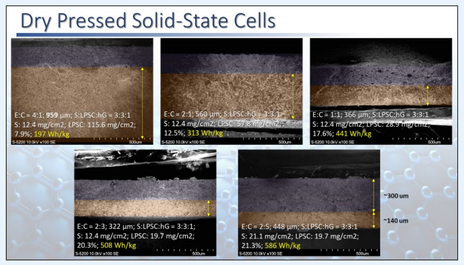


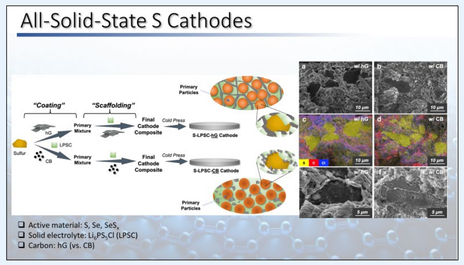


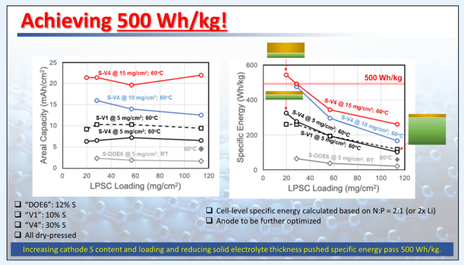


a) Cathode microstructure model b) Introduction of holey graphene in model c) Computational prediction based on experimental data

Coin Cell Development







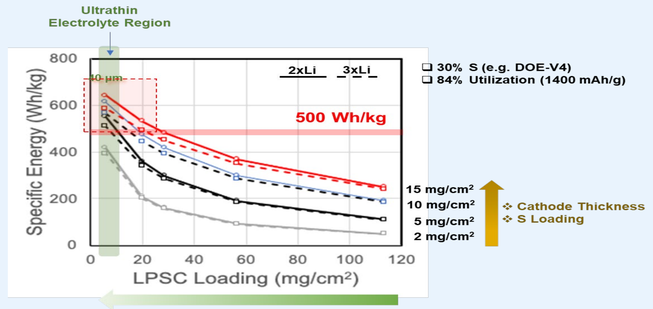
a) Energy density of dry pressed cells b) Effect of carbon type on cathode microstructure c) Compositions that achieved 500 Wh/kg

Results

- Improved design optimization with computational modeling of the cathode microstructure based on experimental results
- Achieved electrochemical-level specific energy of greater than 500 Wh/kg in coin cells
- Achieved high-temperature (100 oC), high rate (up to 4C; ultrahigh current density >30 mA/cm2) all-solid-state cells
- Demonstrated successful scale-up
- Investigated various processing techniques for pouch cells

Next Steps

- Employ ultra-thin reinforced sulfide and polymer solid electrolytes (SE)
- Improve cyclability through Li-metal anode and Li-SE interface engineering
- Improve reproducibility of pouch cells to increase production rate
- Fabricate SABERS bipolar stack



Partners and/or Participants

- NASA Glenn Research Center (GRC)
- NASA Langley Research Center (LaRC)
- NASA Ames Research Center (ARC)
- Argonne National Lab
- Pacific Northwest National Lab

IMAGINAVIATION

POC: Rocco Viggiano, GRC

Co-PI: Yi Lin, LaRC and Donald Dornbusch, GRC

CONVERGENT AERONAUTICS SOLUTIONS

IMAGINAVIATION