SD NASA EPSCoR 2014 Major Research Grant
(Approved for funding Sept. 1, 2014 – Aug. 31, 2017)

South Dakota investigator(s) and affiliation	Project title	Funding summary	NASA and other partners
• PI at SDSM&T: **Edward F. Duke**, Director SD NASA EPSCoR • Co-I's at SDSMT: **Alla Smirnova**, **Hao Fong** • Co-I's at SDSU: **Qiquan Qiao**, **Huitian Lu** • Co-I's at USD: **Ranjit Koodali**, **Haoran Sun**, **James Hoefelmeyer** • Industry Partners: **Robert Daniel Cook** (Zyvex Technologies), **Chengsong Ma** (Saft America, Inc), **Wendell Rhine** (Aspen Aerogels, Inc)	High Performance and Durable Lithium-ion Battery for NASA Space Applications	$750,000 (NASA) $378,504 (Match)	• NASA Glenn Research Center • Argonne National Lab • Environmental Molecular Sciences Laboratory • Zyvex Technologies • Space Information Laboratories • Global Technical Programs • FMC Minerals • Oglala Lakota College

Project Summary
(Funded South Dakota NASA EPSCoR 2014 Major Research Project)
High Performance and Durable Lithium-ion Battery for NASA Space Applications

This project addresses the grand challenge of energy generation and storage related to lithium-ion (Li-ion) batteries. The main goal of the project is to develop and introduce to the market the next generation Li-ion battery with high-performance, ultra-high power density, extended cyclability, and safe operation at elevated temperatures. The challenge of safe and efficient energy storage is dominant in NASA research. It is one of the central components of the NASA Strategic Plan, the NASA Space Power and Energy Storage Roadmap (TA03) and all four NASA Mission directorates. The importance of energy storage system design, materials development, and modeling is further emphasized in the NASA Space Technology Roadmaps with respect to Nanotechnology (TA10); Modeling, Simulation, Information Technology, and Processing (TA11); and Materials, Structures, Mechanical Systems and Manufacturing (TA12); all are directly related to this project. Development of an Ultra-High Energy (UHE), durable and safe Li-ion battery will be achieved by introducing: (1) Nano-engineered silicon anode in combination with (2) An advanced electrospun separation membrane; (3) High energy cathode with improved cyclability; (4) Non-flammable electrolyte; and (5) A comprehensive electro-thermal battery prediction model. These objectives align closely with the new (2013) South Dakota Science and Technology Plan, where three out of five specific research and development target sectors are directly related to safe and efficient power generation and storage, specifically: (1) Energy and Environment; (2) Materials and Advanced Manufacturing; and (3) Agriculture and Agribusiness. To reach the goal, a multi-institutional and multi-disciplinary team has been assembled from three South Dakota universities (i.e., South Dakota School of Mines and Technology, University of South Dakota, and South Dakota State University), two national laboratories (i.e., Pacific Northwest National Laboratory and Argonne National Laboratory), and five industry partners (i.e., Zyvex Technologies, Aspen Aerogels, SAFT, Space Information Laboratories, and FMC Corporation) in collaboration with both the Electrochemistry and Ceramics Branches at the NASA Glenn Research Center. As a part of the project, a novel educational plan focused on training of American Indian students in sustainable energy has been developed. It involves two K-12 schools on South Dakota Indian reservations (Red Shirt and Red Cloud Schools), Oglala Lakota College (a Tribal College), the Office of Indian Education in Rapid City Schools, and the Office of Multicultural Affairs at South Dakota School of Mines and Technology. A synergistic combination of novel approaches in nano-engineering and fundamental understanding of the electrochemical transport and kinetic properties of the materials will result in a mechanically durable anode with minimized irreversible capacity loss, thermally and chemically stable electrospun polyimide separation membrane, non-flammable electrolyte, and nanostructured cathode with protective ceramic coating for extended cyclability. Supported by an advanced computational thermal-electrochemical model to predict and understand the complex system phenomena, these components will result in a UHE Li-ion battery prototype for NASA space applications. Sustainability in battery R&D will be achieved by establishing new spin-off companies with the additional goal of system manufacturing that can rely on wind/solar energy and safe energy storage in South Dakota. New programs and courses in sustainable energy will be developed at three South Dakota universities that will disseminate the knowledge, contribute to the STEM workforce, and establish a technical background for large-scale manufacturing of UHE Li-ion batteries.

NASA received a total of 25 proposals for this solicitation. From these, 15 were recommended for funding. The proposal earned very good reviews. As excerpted from the panel summary: "We are really interested in this topic (Lithium line batteries) … We are looking for this… Future funding is possible."

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