High Energy Density Lithium-Sulfur Batteries for Aerospace Applications

Ratnakumar Bugga*, Simon Jones, Jasmina Pasalic, Loraine Torres,
Jet Propulsion Laboratory, California Institute of Technology,
4800 Oak Grove Drive, Pasadena, California 91109
*rvbugga@jpl.nasa.gov

NASA’s upcoming missions need energy storage systems with enhanced performance, especially higher specific energies and energy densities, beyond the capabilities of Li-ion cell. One such application involves astronaut Extra Vehicular Activity (EVA), wherein the astronaut’s Portable Life Support System (PLSS) is expected to support 8 hours of EVA. The state of art (lithium-ion) batteries with ~200 Wh/kg at the cell level can support only four hours of EVA. To address these needs, we are developing high-energy and long-life lithium-sulfur cells, with the following performance targets: cell specific energy of 400 Wh/kg ii) cycle life exceeding 200 cycles and iii) ability to operate safely over a wide temperature range of -10 to +30 °C. We have been developing improved cell components for Li-S cells, e.g., a protected Li anode, a dense sulfur cathode and compatible electrolytes, mainly addressing the key technological hurdles of poor utilization at high cathode loadings (necessary for a practical high energy cell) and limited cycle life. We have developed new sulfur cathodes with metal sulfide blends that show high specific capacities of ≥800 mAh/g at C/3 rates with practical material loadings, ii) a Li anode protected with a polymer electrolyte that displays efficient Li cycling and durability in laboratory Li-S cells, and iii) Electrolytes and new proprietary coatings serving as polysulfide blocking layers which inhibit the deleterious effects of sulfur redistribution and contribute to a good cycle life. In this paper, we will describe some of these material developments and their performance in laboratory cells and later in prototype cells.