High Energy Density Lithium-Sulfur Batteries for Aerospace Applications

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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.[1-4] 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.

1. Y. Yin, S. Xin, Y. Guo and L. Wan, *Angew. Chem. Int. Ed*. 2013, 52, 13186 (2013).
2. S. Evers, L. F. Nazar, *Acc. Chem. Res*., 46, 1135 (2013);
3. X. Ji, K. T. Lee, L. F. Nazar, *Nat. Mater*. 8, 500 (2009).
4. A. Manthiram, S.-H. Chung, C. Zu, *Adv. Mater.* 27, 1980 (2015).
5. S. S. Zhang, *Front. Energy Res.* 1, 1 (2013).