Applications Keynote Abstract & Speaker Biography

High Energy Density Lithium-Sulfur Batteries for NASA and DoD Applications

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Li-ion batteries, being compact, lightweight and durable, have contributed to a significant enhancement or even enablement of several planetary and space missions. However, NASA's future missions, e.g., Astronaut's Portable Life Support System (PLSS) for Extra-Vehicular Activities (EVA), small planetary rovers, planetary probes, CubeSats etc., require battery technologies with higher specific energies and energy densities, albeit for short cyclic lifetimes.

The lithium-sulfur system emerges as the most viable 'beyond lithium-ion' technology, because of its high theoretical specific energy (3-4x vs Li-ion). However, Li-S technology hasn't matured yet, mainly due to the challenges from the soluble polysulfides forming a redox shuttle and also poisoning the lithium anode. Several attempts were reported in the literature with novel cathode designs, e.g., hierarchical porous carbon structures to sequester sulfur and its reduction products, and also with electrolyte solutions to minimize their solubility. [1-3] Good cycle life was achieved in some of these cases with nanostructured sulfur cathodes in both organic electrolytes containing suitable additives (LiNO3) and in ionic liquids, but the sulfur loadings are much lower (below 4 mg/cm2), while high loadings of >12 mg/cm2 are essential for realizing high specific energy from a Li-S cell.

Recently, our group[4] and several others[5,6] have been developing new sulfur composite cathodes blended with transition metal sulfides (e.g., titanium and molybdenum disulfide), which not only provide good electronic and ionic conductivity, but assist in the trapping of polysulfides within the cathode. In this paper, we will describe the performance of these composite sulfur cathodes in different electrolytes, and also in conjunction with a protected Li anode.

References

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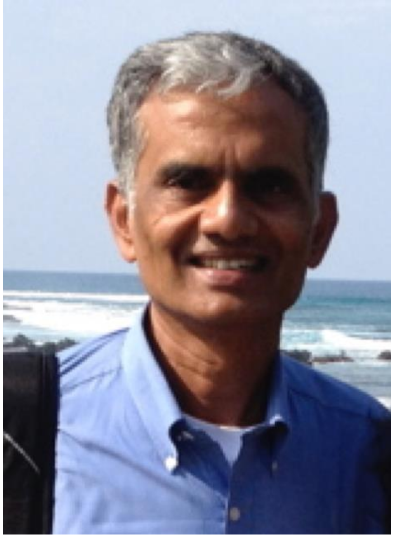
Speaker Biography:



Ratnakumar Bugga received his Ph.D. in Electrochemistry from the Indian Institute of Science, Bangalore, India in 1983. Currently a Principal Member Technical Staff, he has been at the Jet Propulsion Laboratory for the last thirty years developing advanced electrochemical energy storage technologies, both primary and rechargeable batteries for space applications.

His research areas include advanced lithium and lithium-ion batteries with novel organic, polymer and solid state electrolytes and with high specific energy cathode and and anode materials, lithium-sulfur batteries, aqueous batteries such as nickel-hydrogen, nickel-metal hydride and metal hydride-air batteries, high temperature sodium rechargeable batteries, advanced primary lithium batteries such as Li-CFx and hydrogen storage materials.

Over the years, he has led the battery efforts on several flight missions including Mars Exploration Rovers, Mars Science laboratory (MSL) and Outer planetary missions (Europa Clipper and Lander). As a PI, he led NASA's Space Power Systems-Battery project for the ten years, on Safe and High Energy Li-ion batteries with Li-rich NMC cathodes, Si anodes and low flammability electrolytes, and the ARPA-E sponsored project on metal-hydride air batteries. He was the recipient of NASA's Exceptional Service medal in 2012.