SAFETY PROTECTION of Li/S BATTERIES

Yuriy V. Mikhaylik*, James R. Akridge
Sion Power Corporation
9062 South Rita Road, Tucson, Arizona 85747-9108 USA

*To whom correspondence should be addressed: Fax: (520) 799-7501; e-mail: yuriy.mikhaylik@sionpower.com

The enthalpy of the Li/S reaction exceeds the theoretical energy of the Li-ion system by a factor of five and exceeds TNT equivalent by a factor of two. Because of this high energy density, Li/S safety is a technical challenge. The present work was specifically targeted to enhance Li/S battery safety and focus on development of reversible protection from over-charge, over-discharge and thermal runaway.

Over-charge. Cells with a low temperature electrolyte have demonstrated discharge rates up to 5 to 14C over a wide range of temperatures (- 40 - +40 ^{o}C) and have provided a very effective shuttle mechanism protecting cells from over-charge [1]. Cells can operate after 200% over-charge at –40^{o}C and 3000% over-charge at room temperature.

Over-discharge. The introduction of a layer with conductivity dependent upon the cathode redox conditions created over-discharge protection. At the end of discharge when the cathode voltage decreases, the accompanying rise in impedance shuts the cell down, thus preventing damage (Fig.1). The cell returns to normal operation once the over-discharge condition is removed. The cells could sustain more than 100 deep over-discharge cycles to 0.0 V (Fig.2). This internal chemistry protection is invaluable for safe use of the battery cells connected in series, should the electronic controls for over-discharge fail or where the weakest cell is exposed to a large over-voltage discharge condition.

Thermal runaway. Further electrolyte development has led to a system with a sharp but reversible conductivity decrease at elevated temperatures (Fig.3). Conductivity decreases of more than 50 fold in a narrow range of temperature prevents the cell from thermal runaway should it be externally or internally shorted.

Continued development in Li/S chemistry is providing a safe response to extreme abuse conditions without the reliance on electronics.

1. Y. V. Mikhaylik, J. R. Akridge, *J. Electrochem. Soc.*, **150**, (2003)

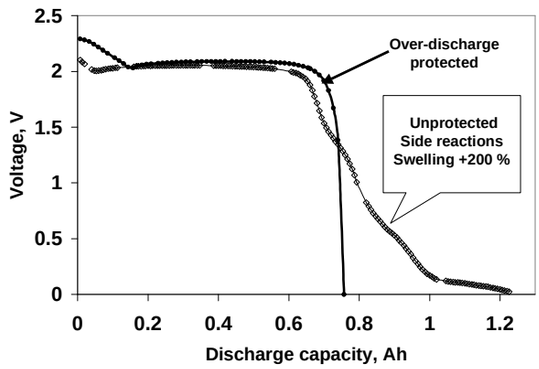

Fig.1. Discharge profiles at deep over-discharge to 0.0 V.

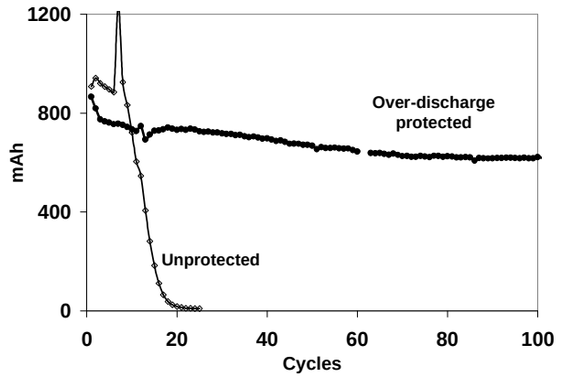

Fig.2. Discharge capacity vs. Cycles at deep over-discharge to 0.0 V

.

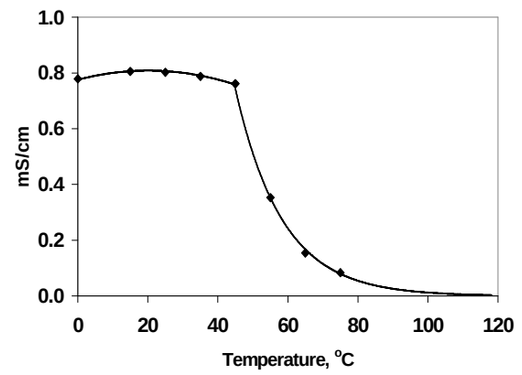

Fig.3. Electrolyte conductivity vs temperature