All-Lithium, Iodide-Based, Low-Melting Electrolytes for High-Temperature Batteries

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A number of electrolytes have been used for Li-alloy/FeS_2 high-temperature (thermal) batteries. These include the standard LiCl-KCl eutectic (m.p. = 352°C) and the all-Li LiCl-LiBr-LiF minimum-melting electrolyte (m.p. 436°C). The latter is typically used for high-power applications because of its high ionic conductivity. It is often paired with CoS_2, which has a higher electrical conductivity than FeS_2.

The high melting point of the all-Li electrolyte limits the function time of the thermal batteries, as once the electrolyte freezes, the battery ceases to function. The absence of aliovalent cations (e.g., K^+) with the all-Li electrolyte eliminates Li^+-concentration gradients and the attendant deposition of solids that would otherwise occur under high-rate conditions.

It would be desirable to extend battery life by using an alternate electrolyte that has a greater liquid range. That was the rationale for the present work. There are a number of iodide-based electrolytes reported in the literature that have lower melting points than the standard LiCl-LiBr-LiF electrolyte. These are summarized in Table 1. These electrolytes were prepared in a glovebox under high-purity argon and were then formulated into separator materials with 35% MgO acting as a binder. The Li(Si)/FeS_2 couple was used for evaluation of these materials in single cells discharged at 125 mA/cm^2 between heated platens over a temperature range of 350° to 550°C. The cells used pressed pellets of the anode, separator, and cathode materials. The relative performance of these cells will be discussed and compared to that of cells with the standard all-Li electrolyte tested under the same conditions. Areas of future work will also be presented.

Table 1. List of All-Li Electrolytes Examined in Characterization Effort for Potential Borehole Use.

Electrolyte	**Composition**	**M.P., °C**
Standard all-Li	LiCl-LiBr-LiF min. melting	436.0
LM ternary #1:	LiI-LiCl-LiF eut.	334.3
LM quaternary #2	LiI-LiBr-LiCl-LiF eut #1	325.4
LM quaternary #3	LiI-LiBr-LiCl-LiF eut #2	326.1

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