Performance of Li-Alloy/Ag_2CrO_4 Couples in Molten $LiNO_3$-KNO_3 Eutectic Electrolyte

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There is interest in the development of a high-temperature power source that can be used to power data logging instrumentation while drilling in geothermal boreholes. Temperature can range from 250°C to well over 400°C in such an environment. To avoid the use of expensive dewar systems, the batteries must be able to function by using the ambient heat in the borehole. Typical electrolytes used in high-temperature (thermal) batteries are halide based with melting points between 313° and 436°C. There is a need to develop electrolytes with much lower melting points for this application. The melting points need to be even lower to function in oil and gas boreholes, where temperatures reach only 250°C or so.[1]

As part of this effort, we have performed a number of compatibility studies with some of the more-promising electrolytes—both inorganic as well as organic.[2] In earlier work, we presented the results of characterization efforts with various electrochemical couples[3] and, more specifically, with the Li(Si)/FeS_2 couple in a low-melting CsBr-based eutectic.[4] The latter systems works fine above 250°C but experiences severe polarization due to higher internal impedance at lower temperatures.

In an attempt to extend the liquid region to lower temperatures, the use of lower-melting electrolytes was explored. One electrolyte that shows promise is the $LiNO_3$-KNO_3 eutectic that melts at 124.5°C. The use of high-activity anodes with this electrolyte is possible only due to the formation of a protective passive film if Li_2O on the anode, much in the same way that a film of LiCl prevents continued reaction of the anode in Li/$SOCl_2$ cells.

A considerable amount of work has been done by Miles in studying the basic electrochemistry of various materials in $LiNO_3$-KNO_3 eutectic.[5] Giwa has also examined the Li(Al)/Ag_2CrO_4 couple with this electrolyte but over a narrow range of discharge conditions.[6,7] In this work, we have extended the range of discharge conditions for this couple and have included the Li(Si)/Ag_2CrO_4 and Li(Si)/Ag_2CrO_4 couples as well. These materials were tested in single cells heated between platens at temperatures of 150° to 300°C at current densities of 8 – 32 mA/cm^2. This paper will report on the performance of these cells and will present preliminary data for 5-cell stacks tested in a simulated borehole environment.

References

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