STUDY OF POSITIVE ELECTRODE AND SEPARATOR FACTORS AFFECTING PERFORMANCE AND LIFE OF LITHIUM/IRON SULFIDE CELLS

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Parametric design studies are being conducted to improve the utilization of the FeS_2 electrode in Li–Al/LiCl–KCl/FeS_2 cells. The parameters under investigation include: (1) electrode thickness; (2) electrode porosity; (3) current collection; (4) electrolyte composition. The utilization of active material in the FeS_2 electrode is determined by observations of the voltage *vs.* time characteristics of small (<10 cm^2) test electrodes under constant current discharge. The electrode potentials are measured relative to a suitable reference electrode. The effects of current density and temperature are also being evaluated.

The results of the studies to date indicate that (1) a porosity of 30% for the uncharged electrode is near the optimum, (2) an electrode thickness of ~3 mm is near the optimum, and (3) the use of 3 - 4 wt.% Vulcan XC72R graphite powder is near the optimum as a current-collector material. Variations in temperature (400 and 450 °C) and current density (2- and 4-h discharge rates) had only a slight effect on the electrode behavior. Of the three parameters investigated to date, improved current collection had the greatest effect in increasing the utilization of the FeS_2 electrode. Studies to evaluate other current collectors and the effect of electrolyte composition are under consideration.

DEVELOPMENT OF *IN SITU* BORONIZATION PROTECTION OF POSITIVE ELECTRODE CURRENT COLLECTORS

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The concept of *in situ* boronization protection for the positive electrode current collector in lithium/metal sulfide batteries recognizes that corrosion-resistant coatings may be susceptible to corrosion of the substrate *via* defects or pinholes. Boride coatings on low-carbon ferrous materials, although showing excellent initial corrosion resistance for this application, may become more susceptible to corrosion *via* slow diffusion of the boride from the surface into the substrate. Such diffusional losses and coating defects can be compensated for by introducing iron borides (Fe_2B and FeB) into the positive active material where they will be available for diffusion to the initially boronized material.

The objective of this program was to give a preliminary demonstration of the basic concept. High corrosion stabilities were found for low-carbon ferrous materials boronized by the IGT pack boronization technique. Boride migration from iron boride-containing positive active material has been demonstrated, which, under long-term battery cycling, is expected to enhance the practical lifetime of the initial coating. Reproducible pack boronization techniques have been developed which allow for the rapid boronization of lithium–metal sulfide components and are readily amenable to commercial scale-up. No cell assembly difficulties were identified as a result of this technique.

Recent publications

1 M. R. St. John and A. F. Sammells, Development of *in situ* boronization protection of positive electrode current collectors, Final Report, June 1979.

INSULATION DEVELOPMENT FOR HIGH-TEMPERATURE BATTERY FOR ELECTRIC VEHICLE APPLICATION

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The objective of this contract is to develop and demonstrate a high-performance vacuum insulation which is capable of withstanding 0.1 MPa (15 psi) plus battery loading with low compression, operating in the 350 - 450 °C range. The developed insulation would allow construction of rectangular, lightweight and low-cost, vacuum-insulated enclosures for electric vehicles using Na/S or Li/MS batteries. The goals of the program are to develop a vacuum insulation with the following properties: thermal conductivity 0.0024 - 0.0035 W/m K (140×10^{-5} - 200×10^{-5} BTU/h ft °F); density 288 kg/m^3 (18 lb/ft^3); compression 10% from 0 to 0.103 MPa (15 psi) load.

A new milestone in high-temperature, load-bearing, preformed insulation has been achieved through Linde's efforts on this program. Prior to this program, the best load-bearing commercial vacuum insulation system had a thermal conductivity six times higher than the goal.