

## Recent publications

- 1 E. L. Littauer, R. P. Hollandsworth and D. J. Levy, Rapidly-refuelable aluminum-air battery, *Proc. Second International Workshop on Reactive Metal-Air Batteries* (Belgrade Meeting), September 2 - 4, 1982, to be published.

## AIR ELECTRODE R & D FOR ALUMINUM/AIR BATTERIES

*ELTECH Systems Corporation, (formerly Electrolytic Systems Division, Diamond Shamrock Corporation), P.O. Box 348, Painesville, OH 44077 (U.S.A.)*

The purpose of this contract is to identify the life-limiting parameters associated with air-depolarized cathodes when used in drive cycles compatible with those anticipated for an electric vehicle. Once these limitations are identified, improved cathodes designed to meet the stringent life-performance-cost criteria demanded by the vehicular use will be fabricated and tested. Optimized electrodes are supplied to the battery development groups.

Conductive wetproof layers made from a blend of carbon and polytetrafluoroethylene (PTFE) were unable to prevent electrolyte from weeping through to the air side. Replacement of this conductive wetproof layer by a pure PTFE wetproof layer increased the lifetime of a cathode made with 10 percent Pt on RB carbon from 100 cycles to nearly 500 cycles. An improved conductive wetproof layer has also been developed that matches the performance of the pure PTFE layer, but preserves the option of electrolyte- or air-side current collection on the cathode.

To determine whether pore blockage by precipitated alumina was a reason for cathode failure, a series of life tests was conducted in which cathodes and operating conditions were identical except for the presence of stannate and aluminate in the electrolyte. The presence of 1 M NaAl(OH)<sub>3</sub> and 0.06 M NaSn(OH)<sub>3</sub> in the electrolyte resulted in an average lifetime of 488 cycles, compared to a lifetime of 280 cycles in 4 M NaOH without stannate or aluminate. The cathodes used in these tests were made with 10 percent Pt on RB carbon and pure PTFE wetproof layers. It was further demonstrated that the rate constant for peroxide decomposition is an order of magnitude greater in the electrolyte with aluminate and stannate than in caustic alone. Because carbon corrosion is believed to be a possible cause for cathode failure, the depressed peroxide concentration in the presence of aluminate and stannate may explain the improved lifetimes.

Cathodes were examined by source-excited fluorescence analysis to determine the rate of platinum loss from electrodes made with 10 percent Pt on RB carbon. A plot of the amount of platinum remaining in the cathodes as a function of time exhibits a logarithmic decay to a nonzero value. Based on these results, it is believed that the gradual decline in cathode performance is due to the loss of the catalyst.

The performance of several alternative catalyst systems was also examined. In particular, cobalt tetramethoxyphenylporphyrin offers greatly improved voltages over platinum. Polymeric cobalt phthalocyanine plus spinel exhibits initial performance inferior to that of platinum but sustains its performance for over 100 cycles. In fact, uncatalyzed RB carbon offers a reasonably good performance-life-cost compromise.

Significant progress has been made in developing cathodes for this application. Improvements in cathode structure and the use of certain non-noble metal catalysts have resulted in an extension of cathode life from 100 cycles in 1981 to 1000 cycles at this date.

The specific objectives of the ELTECH cathode development program for 1983 are as follows:

- Develop a nonprecious metal catalyst for an air cathode with adequate performance to 1500 cycles;
- Identify the optimum structure and physical properties of a cyclically driven air cathode; and
- Determine the role of carbon corrosion in the failure of air cathodes.

## CONTROL OF ELECTROLYTE COMPOSITION

*Aluminum Company of America, Alcoa Laboratories*

The objective of this research was to develop and demonstrate processes and components for the control of aluminum/air battery electrolyte composition through the precipitation of aluminum trihydroxide. The tasks under this contract included the following:

- Determine the physical properties of the circulating electrolyte as a function of its chemical composition and temperature;
- Establish conditions for hydrolysis of the electrolyte that will yield crystals of the desired particle size at rates sufficient to permit battery operation; and
- Develop engineering data for separation and washing of the aluminum hydroxide reaction product.

The contract was completed in April 1983 and a final report was published in May 1982. The following is a summary of the results of this work.