occurring in 5A- and 6A-grade primary aluminum would cost 15 cents/lb over 3A-grade molten aluminum costs (3.5 cents/lb for premium purity, 2.4 cents/lb for alloying agents (principally, manganese and gallium), and 9.0 cents/lb for continuous casting and shearing). Anodes could be produced with 0.03 percent Fe using Hall cell metal and continuous casting by the use of specially prepared aluminas, such as some chemical-grade products. This would add another 10 to 15 cents/lb to the cost, over the 15 cents/lb described above. It is not feasible to produce lower iron anodes directly from Hall cell metal.

The contract has been completed.

Recent publications

1 C. J. McMinn and J. A. Branscomb, Production of anodes for aluminum–air power cells directly from Hall cell metal, *LLNL UCRL-15354*, Reynolds Aluminum, Reduction Research Division, Sheffield, AL, February 12, 1981.

2 P. McNamara and D. H. Scott, Aluminum auto battery summary report 1980, *MRD 80-25*, Reynolds Metals Co., Metallurgical Research Division, December 1980.

3 D. H. Scott, The effect of manganese additions on the performance of aluminum/air battery anode alloys, *MRD 82-14, UCRL-15478*, Reynolds Metals Co., Metallurgical Research Division, May 1982.

ALUMINUM DISSOLUTION RESEARCH AND DEVELOPMENT

Institute of Electrochemistry, Belgrade

The objective was to investigate the electrochemical properties of certain aluminum alloys containing gallium and phosphorus in neutral and alkaline electrolytes.

The research project consisted of the following:

- A number of alloy samples were made from high-purity aluminum (99.999) in the form of blocks 50 mm × 50 mm × 5 mm by splat-cooling from the melt. The alloys covered a range of gallium and phosphorus contents.
- The samples were submitted to electrochemical investigations consisting of the following measurements at 30 °C and 60 °C in both neutral (2 M NaCl) and alkaline [(4 M NaOH + 1 M $Al(OH)_3$ + 0.06 M $Na_2Sn(OH)_6$)] solutions:
  - Open-circuit potential (OCP),
  - Corrosion rate at OCP and at 150 mA/cm^2,
  - Polarization curve (to 200 mA/cm^2), and
  - Relaxation time constant of polarization.

- The compositions exhibiting most-favorable characteristics (largest quality number) were submitted to metallurgical characterization.
- Technical grade aluminum (99.5 and 99.8) was collected from different sources and submitted to impurity analysis.
- The alloy of the most favorable composition was made in a number of samples using different base metals.

Several conclusions can be made:

- Addition of phosphorus tends to decrease the potential in neutral solution in some proportion to its concentration.
- Corrosion rates in neutral solution are similar to those of alloys with no phosphorus added.
- In alkaline solutions, there is a dramatic increase in corrosion rates with any addition of phosphorus.
- The above conclusions apply both to alloys derived from a high-purity base and to those derived from technical-grade metals. However, all the effects are amplified when technical-grade metals are used. Corrosion rates were especially amplified and in many instances were above the upper limit of the method of measurement.
- There were two alloys having exceptional qualities in the neutral electrolyte. In spite of thorough investigation of possible reasons, no difference from other alloys in the content of alloying elements, impurities, or mode of preparation and metallurgical properties could be found. Alloys having similar properties could not be refabricated.
- Metallographic investigations have revealed a beneficial effect of phosphorus on the type of corrosion of the aluminum alloys in the neutral solution. This consists of the fact that intergranular corrosion is characteristic of aluminum–gallium alloys leading to disintegration of samples into powder before the bulk of the metal is dissolved anodically. In the presence of phosphorus there is some pitting corrosion but the metal retains a generally smooth surface with no sign of disintegration. A similar pattern of behavior is found in anodic dissolution. The pitting in alloys based on technical grade metal, however, is very pronounced. Still, it does not lead to disintegration of samples into powder.

The contract was completed in April 1982.

Recent publications

1 A. Despic and D. Drazic, Electrochemical properties of alloys of aluminum with gallium and phosphorus, Final Report 1981/82, *URCL-15481*, Institute of Electrochemistry ICTM, University of Belgrade, June 1982.