rate to make a spinel ($LiMn_2O_4$) with predetermined stoichiometry. X-ray diffraction cannot readily distinguish the different phases of lithium manganese oxide. The manganese and lithium analyses carried out by ICPAES in duplicate are in good agreement. It was observed that the oxygen contents of spinel samples fall with increasing temperature and also the particle size results are in good agreement for the sieving technique and for the laser diffraction method. Furthermore, spinels prepared at 850°C appear to be in good agreement with the values on the J.C.P.D.S. card.

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Development of a lithium-ion polymer battery for space power applications

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Introduction

In recent years lithium-ion batteries [1] have emerged as the leading advanced power source for a range of applications. Driven by the demands of the portable consumer market, small lithium ion cells are now available commercially and have demonstrated excellent cycle life and safety characteristics.

Here we report results from a project aimed at developing a lithium-ion polymer battery (LiPB) into a power source for GEO satellites. The LiPB technology combines the cycle life and safety benefits of the lithium-ion chemistry with those of flexible cell geometry afforded by the use of a solid polymer electrolyte. The concept of the all solid state battery is very appealing. Solid state batteries are intrinsically spill proof and rugged, have long shelf-life, and are capable of being engineered into any geometry. LiPB is a laminate structure based on $LiNiO_2$ as the active cathode material [2] and graphite as the active anode material. The average cell voltage during discharge is about 3.5 V.

Experimental

The composite anode, polymer electrolyte and composite cathode components of LiPB can be easily prepared using a range of coating techniques. Fabrication of LiPB laminate is achieved using a combination of heat and pressure.

Electrochemical evaluations under GEO space power duty cycle were performed on 56 cm^2 LiPB cells using Sycopel charge/discharge equipment.

Results and discussion

LiPB technology demonstrates significantly improved performance compared to our previously reported lithium metal anode polymer system [3]. Over 500 cycles have been obtained to date at 60% depth of discharge under a GEO duty cycle. A comparison with state-of-the-art liquid electrolyte cell technology indicates that lithium-ion chemistry is capable of achieving in excess of 1000 GEO cycles at 80% depth of discharge.

References

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Parallel cell arrangements for reserve lithium/sulphuryl chloride batteries

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The aim of this work was to investigate the processes leading to failure of large capacity reserve oxyhalide batteries. Previous work in our laboratories has shown that smaller (<600 Wh) systems, using thionyl or sulphuryl chloride cathodes, have good reliability and predictable behaviour. However, on scale up to larger sizes, premature failure has been observed. Among the factors most responsible are excessive heat generation, leakage currents and lithium dendrite formation.

We report a part of this work concerned with minimising overall leakage currents and heat output through use of parallel arrangements of cells. Where higher currents are required it has been typical practice to make use of parallel sets of series piles. However, if the cells are coupled in parallel before being placed in series, the overall leakage current and heat output can be reduced.

Batteries of five paralleled strings, each string containing four cells in series, were compared with batteries of twenty, series-connected cells. Results showed that the heat output was some 44% less for the parallel arrangement at 25 mA cm^{-2}. Some other important observations were that, in a set of five parallel cells, the cells discharged at different rates (up to 50 mA cm^{-2} and as low as 10 mA cm^{-2} initially). As the higher rate cells became exhausted their current output reduced and the current output from the other cells increased. This current balancing appears to be beneficial in terms of