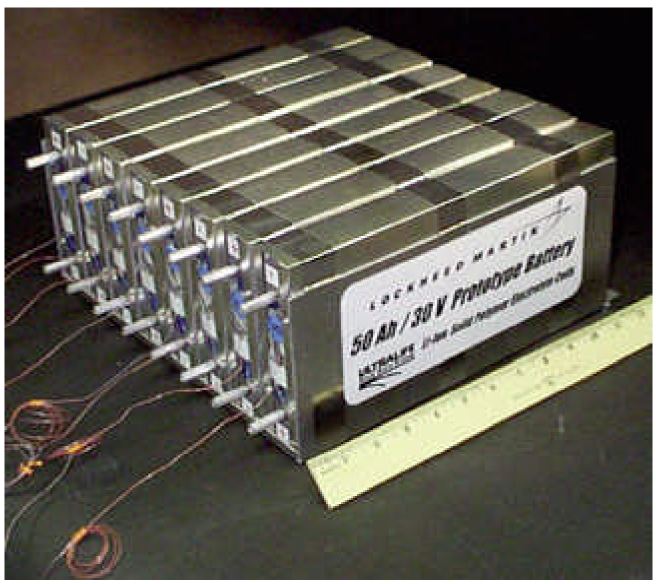
Lithium-Ion Polymer Rechargeable Battery Developed for Aerospace and Military Applications

A recently completed 3 ½-year project funded by the Defense Advanced Research Projects Agency (DARPA) under the Technology Reinvestment Program has resulted in the development and scaleup of new lithium-ion polymer battery technology for military and aerospace applications. The contractors for this cost-shared project were Lockheed Martin Missiles & Space and Ultralife Batteries, Inc. The NASA Lewis Research Center provided contract management and technical oversight. The final products of the project were a portable 15-volt (V), 10-ampere-hour (A-hr) military radio battery and a 30-V, 50-A-hr marine/aerospace battery. Lewis will test the 50-A-hr battery.



50 A-hr, 30-V lithium-ion polymer battery.

The new lithium-ion polymer battery technology offers a threefold or fourfold reduction in mass and volume, relative to today's commonly used nickel-cadmium, nickel-hydrogen, and nickel-metal hydride batteries. This is of special importance for orbiting satellites. It has been determined for a particular commercial communications satellite that the replacement of 1 kg of battery mass with 1 kg of transponder mass could increase the annual revenue flow by $100 000! Since this lithium-ion polymer technology offers battery mass reductions on the order of hundreds of kilograms for some satellites, the potential revenue increases are impressive.

By the end of the project, the best high-energy formulations for the electrodes and electrolyte were providing 170 watt-hours per kilogram (W-hr/kg) specific energy and nearly 450 W-hr/liter energy density for the lithium-ion polymer cell. Battery cells have been tested to 1000 deep-discharge cycles before 20 percent of capacity has been lost. We anticipate that continued improvements in cell chemistry coupled with cycling to less than full discharge will result in the cycle lives required for low-Earth-orbit applications. Electronic circuitry has been developed to provide for charge-discharge control, cell protection, and cell rebalancing at the individual cell level. In the lithium-ion polymer cell, there is no metallic lithium, so the safety concerns associated with that metal are obviated. In a typical cell formulation, the negative electrode is a carbon material that can accept (intercalate) lithium ions at a low potential, and the positive electrode is a transition metal oxide that intercalates the ions at a potential about 4 volts higher. The two electrodes and the electrolyte structure all have as one component a thermoplastic polymeric material. Thus, the three cell elements can be independently processed using common high-speed plastic film processing technology. They can then be brought together, thermally bonded to one another, cut to the desired size and shape, activated, connected to form batteries, packaged, sealed, and tested. This entire process, which can be fully automated, uses inexpensive materials and offers the promise of an extremely attractive advanced technology at a low cost.

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