

**Paper Abstract for "Technology 2004" Convention.**  
**Title: "Lithium Rechargeable Batteries for Space Applications"**  
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Performance parameters of lithium - titanium disulfide (Li-TiS<sub>2</sub>) make it a likely candidate to replace NiCd batteries on satellites and spacecraft. Li-TiS<sub>2</sub> batteries are 3-4 times lighter than the equivalent NiCd counterparts. Many planners of future space missions that will use batteries are interested in the lithium technology which means that lithium battery manufacturers will have a new market to pursue. JPL is proceeding on a course that should facilitate opening this market. A ground based program is developing AA and 3 Ah cells using the Teguchi method. At the same time a feasibility study was started to validate the performance of different types of lithium batteries in space. An inexpensive Get-Away-Special based experiment will test Li-TiS<sub>2</sub>, lithium-ion and lithium polymer batteries for performance in microgravity. The effects influencing charge/discharge and cycle life properties will be investigated. This project is sponsored by NASA Code CF under the In-Space Technology Experiments Program (In-STEP).

Lithium has the highest oxidation potential ( $E^{\circ}=4$  V) and lowest equivalent weight (6.94 g/equivalent) of all atoms (other than hydrogen). Accordingly, electrochemical cells comprising lithium anodes have high specific energies. Until recently, cycling of lithium electrodes was limited to a few cycles. Also, selection of a cathode that would cycle in the presence of lithium was also considered difficult. Recently, however, at JPL the Li-TiS<sub>2</sub> cells achieved 1000 charge/discharge cycles at 20°C. These cells operate at 2V and have demonstrated 130 Wh/kg at the C/4 rate when operated to 50% depth of discharge. The 130 Wh/kg specific energy and 1000 cycles demonstrated is the highest reported for a lithium rechargeable system.

The paper will describe the current lithium battery development program including the In-STEP experiment. We will explain how the program is designed to allow the American battery manufacturers to be the partner in the program allowing immediate technology transfer. The paper will comment on the lithium technology market opportunities for the American industry.