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A rechargeable lithium battery operation performance model under development for aerospace missions

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ALTADENA, CA Global Aerospace Corporation (GAC) announced today that, in collaboration with NASA's Jet Propulsion Laboratory (JPL), it is managing a $749,000 Phase II Missile Defense Agency (MDA) Small Business Technology Transfer (STTR) Program funded contract to develop a prototype, high-fidelity, first principle-based, comprehensive, and user-friendly software model, called Dakota, to predict the long-term behavior of advanced rechargeable Lithium Ion batteries in aerospace applications.

The development of the Dakota model for Li-based batteries will enable managers, satellite designers and cell manufacturers to predict performance and life of a cell or battery; to simulate physical changes during operation, e.g., cell imbalance; to optimize cell / battery designs and configurations; to assess capability for a cell or battery design to meet a specific mission requirement; to monitor and manage battery flight operations for long-term success; to assess new cell / battery technologies; to design and size power subsystems; and to potentially map and simulate manufacturing processes. In addition to aerospace applications, the Dakota model will be adaptable for predicting the performance and life of terrestrial applications such as electric vehicle batteries.

Lithium-Ion-based cells and batteries are being used in many terrestrial applications and in a few short duration space missions, however, being a relatively recent electrochemical technology, the degradation mechanisms of Li-Ion rechargeable cells have yet to be completely understood nor is there adequate test data for very long-life aerospace applications to predict performance and life. Presently, it is difficult, if not impossible, to predict performance of a specific cell or battery design without conducting a real-time life cycling test since this would delay (by 5 or 10 years) making decisions regarding technology insertion. This problem is especially acute for low Earth orbit (LEO) space missions, of interest to the aerospace community, that have many thousand charge/discharge cycles every year. To date, statistical, empirical, and other mathematical methods have been unsuccessful in predicting performance and life of Li-Ion rechargeable batteries for LEO missions.

According to Dr. Gerald Halpert, a Senior Research Engineer, GAC's innovative Li-Ion battery operation model will 1) incorporate in one tool, the latest state-of-the-art first-principles Li-Ion cell physics and chemistry; 2) predict cell or battery performance for a variety of Lithium cell chemistries; 3) facilitate the extension and advancement of first-principles cell models; and 4) be extremely user-friendly so as to encourage its use among satellite power systems and battery engineers and cell manufacturers. In Phase II, GAC is extending the capability of the model developed in Phase I by incorporating additional cell and battery design and operational conditions that affect degradation and performance predictions. GAC will validate the Dakota model using low Earth orbit (LEO) cycling data from cell and battery laboratory tests carried out by JPL. Finally, GAC will demonstrate that the prototype battery operation model can predict the performance and life of batteries of a space mission of interest to the MDA over a range of operating scenarios.
