Composite Cathodes for Dual-Rate Li-Ion Batteries

A battery could have both high charge capacity and high rate capacity.

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Composite-material cathodes that enable Li-ion electrochemical cells and batteries to function at both high energy densities and high discharge rates are undergoing development. Until now, using commercially available cathode materials, it has been possible to construct cells that have either capability for high-rate discharge or capability to store energy at average or high density, but not both capabilities. However, both capabilities are needed in robotic, standby-power, and other applications that involve duty cycles that include long-duration, low-power portions and short-duration, high-power portions.

The electrochemically active ingredients of the present developmental composite cathode materials are the following:

- Carbon-coated LiFePO₄, which has a spe-
cific charge capacity of about 160 mA-h/g and has been used heretofore as a high-discharge-rate cathode material; and
• Li[Li$_{0.17}$Mn$_{0.58}$Ni$_{0.25}$]O$_2$, which has a specific charge capacity of about 240 mA-h/g and has been used heretofore as a high-energy-density cathode material.

In preparation for fabricating a composite-material cathode in the approach followed thus far in this development effort, the aforementioned electrochemically active ingredients are incorporated into two sub-composites:
• A mixture comprising 10 weight percent of poly(vinylidene fluoride) [PVDF], 10 weight percent of carbon, and 80 weight percent of carbon-coated LiFePO$_4$ and,
• A mixture comprising 10 weight percent of PVDF, 10 weight percent of carbon, and 80 weight percent of Li[Li$_{0.17}$Mn$_{0.58}$Ni$_{0.25}$]O$_2$.

In the fabrication process, these mixtures are spray-deposited onto an aluminum current collector. While the two mixtures could be spray-deposited simultaneously on the same current-collector area to obtain a single layer comprising a mixture of two sub-composites, electrochemical tests performed thus far have shown that better charge/discharge performance is obtained when either (1) each mixture is sprayed on a separate area of the current collector or (2) the mixtures are deposited sequentially (in contradistinction to simultaneously) on the same current-collector area so that the resulting composite cathode material consists of two different sub-composite layers.

This work was done by Jay Whitacre, William West, and Ratnakumar Bugga of Caltech for NASA’s Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-44837