TECHNOLOGY FACT SHEET

REDUCING IRREVERSIBLE CAPACITY LOSS IN LITHIUM ION BATTERIES

(Jow, Zhang, Xu)

Introduction

This invention represents a significant development in lithium-ion (Li-ion) rechargeable battery technology. Researchers at the Sensors and Electron Devices Directorate of the U.S. Army Research Laboratory (ARL-SEDD), Adelphi, Maryland designed, synthesized and performed successful trials on a series of non-aqueous, propylene carbonate (PC)-based electrolytes featuring a novel combinations of solvents, salts and electrolyte additives. The use of these electrolyte systems shows a substantial reduction in first cycle irreversible capacity loss and an increase in capacity retention, especially at elevated temperatures.

Concept

A system is only as good as the sum of its parts. This is especially true when it comes to electronics. Batteries are an integral part of electronic systems, whether they are in a car, consumer products or a military system. They typically carry the important responsibility of powering key functions of the system. If the battery in a car is dead, it can't drive anywhere; if the battery in a cell phone is dead, it can't make a call; and if the battery in a weapon system fails, the mission fails.

Reduced irreversible capacity loss translates to longer run time for cordless power tools (source: US Gov't)

Increasingly, the market is turning to Li-ion batteries. The main advantages of Li-ion battery technology are low weight and extended run time, which makes it an ideal solution for a multitude of commercial and military applications. One of the more difficult challenges for further development is to increase cycling capacity. High performance anodes use carbon-based materials, but this results in the formation of a solid electrolyte interface layer (SEI), which produces an irreversible capacity loss. The ARL invention reduces such capacity loss by creating a highly stable and conductive SEI layer, improving cyclic life as well as storage life and charge retention.

Invention Overview

- *Reduces first cycle irreversible loss of charge capacity by about one-half when compared to existing Li-ion cells*
- *Increases capacity retention of Li-ion battery at elevated temperatures*
- *Method is simple to practice and adaptable for mass production*
- *TRL 5 – Fully functioning battery prototypes featuring these innovations*
- *Laboratory test data available*
- *US Patents 7,172,834 and 7,524,579*

Doing Business with ARL

- *ARL-SEDD is a leader in partnering with domestic firms*
- *Successfully developed and implemented innovative tools to ease the technology transfer process*
- *Tools includes Patent License Agreements (PLAs); Cooperative Research and Development Agreements (CRADAs); Test Services Agreement (TSA); and others*
- *Visit www.arl.army.mil for more information*

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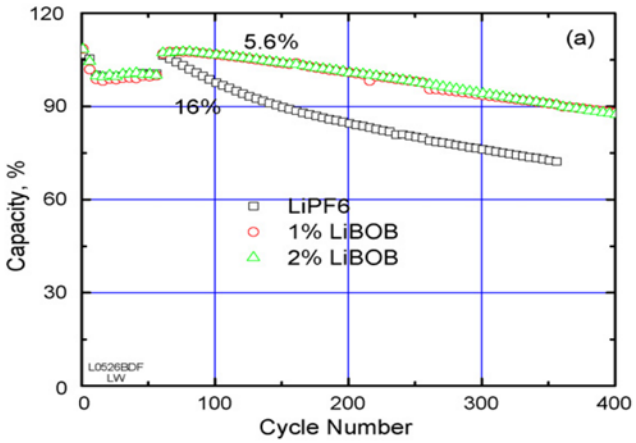
Features/Capabilities/Intellectual Property

Among the numerous forms of carbon materials useful in Li-ion batteries, the most energetically favorable are the ones with a graphite structure, as the corresponding cell will deliver energy at high and steady cell voltage. The graphite structure is very sensitive, and its use along with the electrolyte solvent with the most favorable cost and electrochemical properties can cause severe initial capacity loss and degradation to the electrode over time, shortening the life of the battery. The incompatibility between the solvent and graphite anodes forces a choice between a cell of higher energy density and a cell for low temperature operation.

Now, according to the ARL invention, it has been found that the first cycle irreversible capacity is reduced by adding a small amount of a novel solvent additive to the state-of-the-art non-aqueous electrolytes. Cells activated with the novel salt mixture present longer cycle life than those without addition of the additives.

Other features/capabilities/ intellectual property offered by this invention include the following:

- Materials used are already common in the industry
- Scalable for use in large and small format batteries
- IP includes novel composition of matter and method for creating same



Solvent additive increases capacity retention of Li-ion batteries at 55 °C (Source: J. Power Sources, 163, 2007, 1074-1079)

Potential Markets/Applications

Higher cycling capacity in Li-ion cells opens up new opportunities for use in hybrid electric vehicles and other high energy density applications (see images above):

- Transportation – US auto manufacturers are producing and continuing to develop transportation systems featuring Li-ion technology
- Electric Grid Services -- Contingency capacity provisions are used by power plants to keep a portion of their capacity on reserve for emergencies.
- Commercial Markets – US electric tool manufacturers Li-ion technology in their cordless power tool lines

Key Advantages & Benefits

- *Improves the cyclic life, storage life, and charge retention.*
- *Reduced anode wear from absorbing Li ions during charge cycle*
- *Compatible with current electrolyte manufacturing processes*
- *Wide variety of potential applications*
- *Inventor team available to work with commercialization partner*

Contact Information

This technology was developed by ARL-SEDD. It is now available for licensing and CRADA opportunities.

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