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ELECTROLYTE FOR NEXT GENERATION 5V LI-ION BATTERIES

(Xu)

Introduction

Lithium-ion (Li-ion) batteries are used in everything from laptop computers, cell phones and hybrid electric vehicles (HEVs). Constant technology advances are driving the need for increased energy performance from these types of batteries. A “next generation” of higher voltage Li-ion batteries is required to meet growing military and commercial demands. The invention describes a series of compounds that can be used as co-solvents, solutes or additives in non-aqueous electrolytes in various electrochemical devices and withstand the higher voltages cited above. The presence of such compounds as either solvent, solutes or additive in electrolytes confers desired interphase properties on high voltage cathode surfaces, so that Li-ion batteries can operate at voltages near 5.0 V with stability that is otherwise impossible with current state-of-the-art electrolytes.

Concept

The major problem this invention is designed to solve is the anodic decomposition potential of electrolytes. By formulating a series of new solvents and additives, the electrolytes of this invention can delay the onset of decomposition on cathode surface through a 5 V threshold. The cycling on various cathode surfaces proves that the electrolyte systems can be used to support the future 5V battery chemistries.

The energy density of Li ion battery is determined by its capacity and cell voltage. The current existing cathode chemistry employed in commercial Li ion batteries operates around 4.0 – 4.2 V. To maximize energy density, the researchers have been trying to develop a battery chemistry that operates in the neighborhood of 5 V. So far limited success has been achieved, mostly due to the absence of an electrolyte system that can remain stable in the potential range. The present invention provides an electrolyte system that remains stable up to 5 V and can effectively support the cell chemistry in prolonged cycles.

Invention Overview

- *Ground breaking invention; enables Li-ion batteries to operate at high voltage (5V); currently impossible with state-of-art electrolytes*
- *Stable; up to 300 cycles at 5V*
- *Easy to produce and scale; “drop in” technology*
- *Works with existing battery designs/architectures*
- *TRL 5 – Well developed & tested*
- *Provisional patent application filed*

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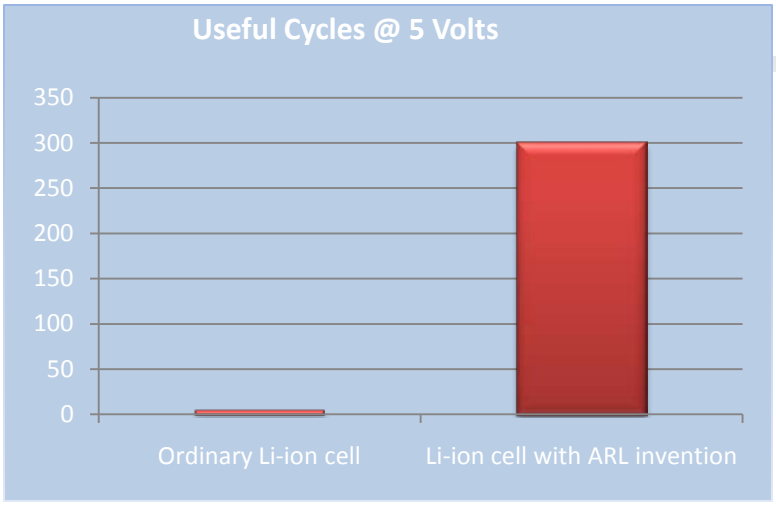
Features/Capabilities/Intellectual Property

Current known electrolyte systems are unable to fulfill the demands of a 5V, non-aqueous electrolyte battery system; namely a low-viscosity solvent system that solvates lithium salt while supporting protective and low-impedance interfacial chemistry. The preliminary results obtained have confirmed that these beneficial effects are universal with cathode chemistries. During initial laboratory experimentation, the test cell lasted up to 300 cycles when charging to 5 volts. As previously noted existing commercial cathode chemistries operate in the 4.0 – 4.2 volt range and as such, would not last more than a few cycles at the higher voltage.

Moreover, the invention demonstrates high energy capacity during useful cycling. Tests show that 83% of initial capacity is retained after 250 cycles. The invention also provides high charge/discharge efficiency. Efficiencies were measured at 99.99% percent after initial cycling. The usefulness of the invention is expected to go beyond Li ion batteries and cover all electrochemical devices that can benefit from high operating voltages. Provisional patent application filed.



Potential Markets/Applications

The invention enables the development of a new, higher voltage (5V) class of Li-ion batteries. Moreover, the electrolyte additive solution will increase the performance of existing, high end Li-ion batteries (4.0V – 4.2V). As such, there are numerous applications and markets for the invention. Many electrolyte manufacturers are currently looking for ways to produce a functional and practical 5 volt lithium ion electrolyte.

Because this invention relates to electrolyte chemistry, other systems employing electrolytes will also benefit, including electrochemical double layer capacitors (supercapacitors), electrolytic cells used in electroplating industry, and pseudocapacitors.

Key Advantages & Benefits

- *Enables high voltage Li-ion batteries (5V vs. 4.0-4.2V).*
- *Up to 300 cycles at 5V; maintains 83% of initial capacity after 250 cycles; 99.99 efficiency after initial cycling*
- *Also benefits 4V; estimated 50-100% more cycles at 4V.*
- *Easy to produce and scale up*
- *Work with existing battery designs/architectures*
- *Can reduce need for booster devices in electronic devices*
- *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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