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Improved Wide-Temperature Electrolytes for Li-ion Batteries using Sulfone Eutectic Mixtures

Background

Lithium-ion batteries (LIBs) exhibit high energy and power densities, and thus are used in widespread applications including powering devices such as laptops and cell phones, to more recent applications such as electric cars. However, LIBs suffer from several issues when used at relatively high or low temperatures, mostly due to the nature and properties of the electrolyte used. At low temperatures, electrolytes can undergo partial/complete crystallization, exhibit sluggish lithium-ion diffusion due to high viscosity, and exhibit higher charge transfer resistance. At high temperatures, lithium salts and carbonate solvents that are commonly used in electrolytes can undergo decomposition/irreversible reactions. This results in unstable electrode-electrolyte interfaces (solid electrolyte interface at the anode, SEI, and cathode electrolyte interface at the cathode, CEI) resulting in increased impedance, reduced capacity retention, and decreased cell performance.

Sulfones have high dielectric constants and exhibit excellent oxidative stability, and have been previously found to be effective solvents for LIB electrolytes. However, they are also known to have high viscosity, poor membrane wettability, and are unable to form SEIs on graphite anodes. In order to exhibit good capacity retention over a temperature range from -20 °C to +60 °C, it is essential for the electrolyte to have the following characteristics:

(a) A liquidus temperature much lower than -20 °C,

(b) High fluidity for good Li-ion diffusivity and ionic conductivity,

(c) The ability to form stable CEI and SEIs to passivate the cathode and anode surfaces and to prevent electrolyte decomposition, and

(d) Good electrochemical stability in the above-mentioned temperature range.

Invention Description

Researchers at Arizona State University have developed novel electrolyte formulations that exhibit wide-temperature range stability for LIBs. This technology uses a combination of different sulfones as eutectic mixtures to lower their liquidus temperature, and cosolvents are added to decrease viscosity. Additives are then used to improve wettability and increase SEI/CEI stability, while ensuring good electrochemical stability and cell performance at -20 °C as well as after storage at +60 °C.

Potential Applications

- Electric vehicles (EV) batteries
- Portable electronics
- Solar energy
- Technology manufacturing

Benefits and Advantages

- Enhanced safety
- Improved performance in extreme conditions
- Cost-effective
- Extended battery lifespan

Related Publication: New sulfone electrolytes for rechargeable lithium batteries. Part I. Oligoether-containing sulfones