Temperature-Responsive Electrolytes for Lithium-Ion Batteries (2014-073)

Polymer Electrolyte Reduces Thermal Hazards Associated with Lithium-Ion Batteries

Market Overview

This polymer electrolyte for lithium-ion batteries can be used to inhibit thermal hazards associated with large-format and high-power lithium-ion batteries. Batteries and energy storage is an expanding market that is worth tens of billions of dollars annually, with the market for Lithium-Ion batteries expected to hit $30 billion by 2020. Due to this market growth, many research efforts aim to either make lithium-ion batteries larger or designing cells that discharge at faster rates to increase power output. Both these endeavors, however, lead to increased thermal hazards such as fires or explosions. Clemson researchers have developed a polymer electrolyte for lithium-ion batteries with temperature responsive properties that can be used to inhibit thermal hazards associated with large-format and high-power lithium-ion batteries. This is achieve by a phase transition that is based on the separation of a polymer from the electrolyte solution. The phase separation results in a decrease in conductivity, preventing battery operation and avoiding destructive safety measures. When the battery cools down, the polymer re-mixes into the solution and the battery regains function. This reversibility allows for prolonged battery life and avoids wasted devices, saving costs for purchases of new batteries and equipment.

Technical Summary

This invention uses a mathematic approach for controlling a multiple radiator electric fan matrix to minimize energy usage for subsequent efficiency gains. The optimization algorithm regulates the electric fan matrix and determines the best combination of electric motor shaft speed and the number of operating axial fan motors. Prototype implementations demonstrate varying fan and speed combinations in order to cool a thermal loaded engine and the use of the mathematical approach. The results verify that this optimization control strategy reduces the fan matrix power consumption by up to 67 percent for the specified thermal load. This creates an improvement in cooling system performance that leads to greater vehicle fuel economy and satisfaction of legislated mobility standards.

Application

Large format Li-ion batteries; vehicles applications; energy storage

Development Stage

Validated Prototype

Advantages

- Incorporates intrinsic safety mechanism that prevents the battery from overcharging or discharging, reducing the thermal hazards associated with lithium ion batteries
- Can be processed in current manufacturing settings, resulting in no additional need for new equipment
- Capable of responding to local hotspots within the battery cell itself

App Type	Country	Serial No.	Patent No.	CURF Ref. No.	Inventors
Utility	United States	14/926,213	NA	2014-073	Dr. Mark E. Roberts Jesse C. Kelly

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Dr. Mark Roberts earned his Ph.D. in Chemical Engineering from Stanford University. Prior to joining Clemson, he conducted Postdoctoral Research at Sandia National Labs and was a Process Engineer at Semitool, Inc. (now Applied Materials). His research interests focus on developing functional polymeric materials with electronic and electrochemical properties

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