Separator Films for Lithium Ion Batteries

Fabricate separator films using electrospray techniques for lithium ion batteries (LIB) that are simple, high quality, and scalable.

Lithium ion batteries (LIBs) are a commonly used type of rechargeable battery with applications in portable electronics, medical, transportation, energy storage, military, electric vehicles, and aerospace. LIBs provide lightweight, high energy density power sources for a variety of devices with excellent energy densities, no memory effect, and only a slow loss of charge when not in use. LIBs typically include an anode and a cathode with a separator composed of dielectric material, which provides physical and electrical separation to prevent electrical short circuits, while also allowing the passage of current in the electrochemical cell. The separator should have proper pore size, density, and thickness to allow good transfer of lithium ions between cathode and anode during charging and discharging. Current separators are created with crude pneumatic spray, which leads to poor quality of the separator, non-uniform pore size, and poor opening area.

Advantages
In contrast, this new method from UCF uses scalable electrospray process to create separator films for lithium ion batteries, relying on flow instability and self-assembly during evaporation to create well-controlled pore size and density. This method is simple, scalable, and environmentally friendly as it uses only a single polymer material (generally a fluoropolymer), and a relatively safe and benign solvent such as acetone, with no need for any particles or a second polymer. Because the solution used is simple and single phase (single polymer and a solvent), the resulting separator film is highly homogeneous. By varying the concentration of the fluoropolymer, you can tune the viscosity of the liquid, and generate thinner or thicker separator films.

Technical Details
This method of forming separators for a lithium ion battery includes a solution of a fluoropolymer dissolved in a volatile solvent. The solution consists of 1% to 5% mass concentration of the fluropolymers, polyvinylidene difluoride (PVDF), in acetone. The solution is finely sprayed with multiplexed electrospraying onto an anode or a cathode surface, providing quasi-monodisperse droplets with drop size of less than 10 microns. The solvent is then evaporated away by heat and/or vacuum to form a separator film with convection cells. After the cells are dried, uniform pores are created. While previous technologies consist of droplets as large as 100 microns, a typical thickness range produced by this method is from five to twenty microns.

This technology is best enhanced when combined with “Electrospray Automization Nozzle, Apparatus, Methods, and Applications” (ID# 32711)

Benefits
- Scalable
- Environmentally-friendly
- Single-phase
- Uniform pores

Applications
- Portable electronics
- Power tools
- Electric vehicles
- Aerospace and defense missions

Tech Fields
Advanced Materials

Keywords
lithium ion batteries, electrospray, PVDF

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