Abstract

Lithium ion batteries (LIBs) find great importance in the present day energy storage systems. Various methods and materials have been developed for improving the performance of lithium ion batteries. Since the electrochemical equivalent and standard potential of sodium are the most advantageous after lithium, and it is also abundant, sodium based energy storage is of great interest to realize lithium-free high energy and high voltage batteries that are environmentally benign. Rechargeable batteries consist of a cathode, an anode, and a separator. The function of a separator membrane is to prevent internal short circuit of the battery while permitting enough number of ions to pass through it. It should be chemically inert with all the other components of the battery.

In this work, polyvinylidene fluoride (PVDF) and poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP), based materials were investigated as separators for lithium ion and sodium ion rechargeable batteries. We have chosen electrospun PVDF, PVDF-HFP membranes as a separator material in Sodium-ion batteries (SIBs), and lithium salt doped electrospun PVDF membranes at different concentrations to be used as separator materials in LIBs. Following the synthesis of these materials, several characterization techniques were employed to analyze them. The X-ray diffraction patterns and fourier transform infra-red spectroscopy revealed the excellent electroactive phase of the electrospun membranes. Our research on fabricating nanofiber-based membranes to design new high-performance separators with high ionic conductivity, high electrochemical stability, good thermal stability, as well as superior electrochemical performance compared to microporous polyolefin membranes.

To design a high-performance separator with enhanced mechanical properties and high thermal stability, a composite membrane was fabricated by simple dip coating technique with polyacrylonitrile (PAN) as matrix and glass fiber mat as reinforcement. It is seen that after saturating liquid electrolyte, the composite membrane exhibited higher ionic conductivity and electrochemical stability than the polyolefin membrane. It was found that the addition of PAN played an important role in improving the overall performance of the fibrous membrane.

In summary, lithium salt doped composite polymer can be directly used as novel battery separators for high performance of lithium-ion batteries. In order to improve electrochemical properties, different polymers were utilized, including homo, copolymer, and ceramic composite polymer to obtain high performance separators for advanced sodium-ion batteries.

Keywords: *Lithium ion battery, Sodium ion battery, Polyvinylidene fluoride, poly(vinylidene fluoride-co-hexafluoropropylene), Polyacrylonitrile, Electrospinning, glass fiber mat.*