EXAMPLE 9

The Crosslinked Composite PVdF-PAN Gel-Type Polymer Electrolyte Membranes as the Separator of Lithium/Polyaniline Secondary Batteries

[0064] Utilizing the crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes that absorbed sufficient electrolyte solution as the separator of lithium/polyaniline secondary batteries consisting of positive electrode, polyaniline carbon black complex; negative electrode, lithium metal. The structure of battery, the 2016 coin-cell battery, is shown in **FIG. 2** and it consists of positive electrode **(21)**, PVdF-PAN composite electrolyte membrane **(22)**, gasket **(23)**, lithium foil **(24)**, spacer **(25)**, and spring **(26)**. The **FIG. 3** is the results of electric capacities vs. cycle number, it displays the electric capacities reach stable within 5 cycles **(31)**, and do not decay until the end of 30 cycles **(32)**. Its efficiency maintains at 99%.

EXAMPLE 10

The Crosslinked Composite PVdF-PAN Gel-Type Polymer Electrolyte Membranes as the Separator of Lithium Ion Secondary Batteries

[0065] Utilizing the crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes that absorbed sufficient electrolyte solution as the separator of lithium ion secondary batteries consisting of positive electrode, $LiMn_2O_4$; negative electrode, lithium metal. **FIG. 4** shows the relationship diagram of electric capacities vs. cycles in the early 30 cycles The electric capacities decay is a native character of lithium secondary batteries, especially at high charging current (0.5° C.) during charging and discharging conditions. As the results shown, using the present invention, crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes, as a separator of lithium secondary batteries can maintain the function of charging and discharging. Furthermore, the electric capacities tend to stable while charging cycles increasing and the efficiency remains at 99%.

EXAMPLE 11

The Crosslinked Composite PVdF-PAN Gel-Type Polymer Electrolyte Membranes as the Separator of Carbon/Polyaniline Secondary Batteries

[0066] The structure is similar to a battery structure of example 9, and the batteries consist of positive electrode, polyaniline carbon black complex; negative electrode, Li-doped MCMB carbon material; separator, crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes. The **FIG. 5** is the results of electric capacities vs. cycle number, it displays the electric capacities reach stable within 5 cycles **(51)**, and do not decay until the end of 40 cycles **(52)**. Its efficiency maintains at 99%.

EXAMPLE 12

The Adhesive Property of Crosslinked Composite PVdF-PAN Gel-Type Polymer Electrolyte Membranes to Positive Electrode, $LiCoO_2$ and to Negative Electrode, MCMB Carbon

[0067] Uniformly coat the crosslinked composite PVdF-PAN gel-type polymer, the pre-polymerizing solution, to a positive electrode, $LiCoO_2$; a negative electrode, MCMB carbon, and then remove the acetone by purging with N_2 gas in the dryer box (the N_2 excluding H_2O and O_2). Finally, copolymerize the AN monomers and crosslinked reagent monomers by heating temperature of 60° C. for 12 h.

[0068] After the manufacturing process mentioned above, can obtain 3 layers structures that are the positive electrode, $LiCoO_2$; the crosslinked composite PVdF-PAN gel-type polymer electrolyte membrane; and the negative electrode, MCMB carbon. The adhesive force on the interfaces of the 3 layers is greater than that of interface between the active material and metal layer.

[0069] In addition, if external drawing force is applied, the peel off will take place between the active material and metal layer. Observing the cross-section by scanning electrical microscopy (SEM), and the picture is shown in the **FIG. 6**, wherein, upper layer is positive electrode, $LiCoO_2$**(61)**; middle layer is crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes **(62)**; lower layer is negative electrode, MCMB carbon**(63)**.

[0070] The present invention has been described with preferred embodiments thereof and it is understood that many changes and modifications in the described embodiments can be carried out without departing from the scope and the spirit of the invention as defined by the appended claims.

What is claimed is:

1. A secondary battery consists of the positive electrode, the crosslinked composite gel-type polymer electrolyte membrane and the negative electrode, wherein, crosslinked composite PVdF-PAN gel-type polymer electrolyte membrane consists of

I. crosslinked gel-type polyacrylonitrile (PAN) electrolyte that copolymerized by:

i. acrylonitrile (AN) monomers and

ii. crosslinked reagent monomers with more than two functional groups that can be copolymerized,

II. polyvinylidene fluoride (PVdF) polymers and

III. liquid electrolytes, which is absorbed in the interpenetrating network (IPN) formed of PAN and PVdF polymers.

2. A secondary battery as claimed in claim 1, wherein said crosslinked composite PVdF-PAN gel-type polymer electrolyte membrane in which liquid electrolytes weight is 10-200 percent of basis polymer of electrolyte membranes' weight.

3. A secondary battery as claimed in claim 1, wherein said the crosslinked composite PVdF-PAN gel-type polymer electrolyte membrane possesses ionic conductivities higher than 1×10^{-4} S/cm.

4. A secondary battery as claimed in claim 1, wherein said the crosslinked reagent monomers have a chemical structure as following: