PAN powders, the results indicate that the uncrosslinked PAN powders decomposed at about temperature of 300° C.; however, the crosslinked PAN electrolyte membranes decomposed at temperature of 360-370° C. The crosslinked PAN electrolyte membranes have higher thermal stability is because of its crosslinked structures.

EXAMPLE 5

Swelling Test

[0059] The good solvent to PAN and PVdF are DMF and acetone, respectively. The swelling test of crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes is proceeded by DMF and acetone, and the results are shown in Table 1.

TABLE 1

Sample	Solvent	Result
PAN electrolyte membranes (uncrosslinked)	DMF	Dissolved completely
Crosslinked PAN electrolyte membranes (example 1)	DMF	Swelling, but not dissolved
Crosslinked PAN electrolyte membranes (example 2)	DMF	Swelling, but not dissolved
PVdF porous membranes (uncrosslinked)	Acetone	Dissolved completely
PVdF-PAN composite polymer electrolyte membranes (example 3)	Acetone	Swelling, but not dissolved

[0060] Although a good solvent can diffuse into the electrolyte membranes that are prepared from example 1, 2 and 3, a solvent cannot further dissociate swelling molecular chains as to those polymer chains linked by chemically crosslinked.

EXAMPLE 6

Absorption Different Concentration of $LiClO_4$/EC/PC Electrolyte Solution via Crosslinked PAN Electrolyte Membranes

[0061] Absorption different concentrations of $LiClO_4$/EC/PC electrolyte solution via crosslinked electrolyte membranes prepared from example 1, measure the electrolyte solution weight absorbed by PAN electrolyte membranes and its ionic conductivities, and the results are shown in Table 2. According to PAN possessing strong polarity, PAN can absorb large amount of electrolyte solution, and its higher ionic conductivities is because of absorbing more larger amount of electrolyte solution.

TABLE 2

Concentration of electrolyte (M $LiClO_4$ in EC/PC(1/1))	Amount of absorbed electrolyte solution[a]	ionic conductivities of PAN electrolyte membrane (10^{-3} S/cm)
0.5	6.35	2.15
1	6.11	2.02
1.5	5.40	1.51
2	5.61	1.3

[a](weight of absorbed electrolyte solution/weight of dry PAN electrolyte membrane)

EXAMPLE 7

The Electrochemical Stability of Crosslinked PAN Electrolyte Membranes

[0062] After absorbing electrolyte solution: $LiClO_4$(11), $LiCF_3SO_3$ (12), $LiBF_4$ (13), and $LiPF_6$ (14), measure the decomposition potential of the crosslinked PAN electrolyte membranes prepared from example 1, and the results are shown in **FIG. 1**. The experiment condition are: working electrode is steel; reference electrode is Lithium metal; scanning rate is 50 mV/S; decomposition potential vs. Li/Li^+. The decomposition potential results are shown in Table 3, and it indicates that crosslinked gel-type PAN electrolyte membranes reveal superior electrochemical stability, its decomposition potential of 5V is great than charge potential of Lithium secondary batteries of 4V.

TABLE 3

Electrolyte solution (EC/PC (1/1))	Decomposition potential (V, vs. Li/Li^+)
1 M $LiClO_4$	5.2
1 M $LiCF_3SO_3$	5.4
1 M $LiBF_4$	6.3
1 M $LiPf_6$	>6.5

EXAMPLE 8

The TGA and Ionic Conductivity Experiments of Crosslinked Composite PVdF-PAN Gel-Type Polymer Electrolyte Membranes

[0063] The different component polymers of the crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes in the example 3 reveal different absorbability. Analysis of different component polymers of the crosslinked composite PVdF-PAN gel-type polymer electrolyte membranes via TGA experiment, and the results of component, amount of absorbed electrolyte solution and ionic conductivities are shown in Table 4.

TABLE 4

Ration of composite polymers (PVdF:PAN)	Absorbed electrolyte solution (%)	The ionic conductivities (10^{-3} S/cm)
1:1	50	0.6
1:2	55.5	1.2
1:3	63.5	1.9