Influence of Ionic Liquid Electrolyte of 1-Methyl-1-Propylpyrrolidinum Bis (Trifluoromethanesulfonyl) Imide/Bis (Trifluoromethane) Sulfonimide Lithium Salt Concentration on Li-Ion Transference Number in Li-Li Ion Cell

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1. Introduction

Rechargeable lithium ion batteries (Li-B) have been widely used, as light weight and high energy density energy storage devices[1]. In Li-ion batteries electrolyte will play a vital role to move the ions[2]. A successful electrolyte will play crucial role isolate the electrons and ion transportation. Organic electrolytes which contains polar groups are attractive as Li-B electrolytes due to their good affinity for Li-ions, low viscosities at room temperature and moderate dielectric constants, the most common electrolytes are ethylene carbonate (EC) coupled with a linear carbonate co-solvents are dimethyl carbonate (DMC), diethyl carbonate (DEC), ethylmethyl carbonate (EMC) and doped with Li-salts like TFSI, and LiPF6 etc., however these organic electrolytes are volatile, flammable, leaky, display poor thermal stability, possess high reduction potentials, which present obvious challenges for new developments in Li-Bs[3]. Ionic liquids have been attracting much attention and considered as potential electrolytes for high-performance and safe due to their low vapor pressure and wide range of electrochemical and thermal stability ranges.

2. Body of abstract

We report a binary electrolytes comprising of bis (trifluoromethane) sulfonimide lithium salt (TFSI-Li) li and ionic liquids (ILs) of 1-methyl-1-propylpyrrolidinum bis (trifluoromethanesulfonyl) imide (MPPY) with various concentrations of TFSI-Li (i.e., TFSI-Li/ MPPY in 0.05:1, 0.25:1, 0.50:1, 0.75:1, 0.90:1 and 1:1, TFSI (pure organic electrolyte was prepared by mixing EC/DEC, 1:1 by v/v and pure IL electrolyte also prepared) have been investigated as safety, ionic conductivity, was measured for binary electrolytes[4]. TFSI-Li salt are potentially a good alternative to $LiPF_6$ since it could both improve the chemical and thermal stability as salt for electrolyte [5]. The initial resistance Rs (Ω) was deceasing with increase of organic electrolyte concentrations and the results are tabulated in Table-1 and shown in Figure-1[6].

Table 1 Determined electrode resistance R_s, and R_{ct} before and after polarization, respectively, Constant phase element (CPE), Warburg constant (W) and Lithium transference number (t_{Li+})

Electrolyte	R_s (Ω)	R_{ct} (Ω)	CPE (μF) x10^{-6}	*W (F $S^{-1/2}$)*
ILs-After	43.50	601.50	4.56	1.785
ILs-Before	39.55	482.30	4.277	20.21
0.05-After	44.03	438.10	3.415	9.877
0.05-Before	42.33	324.40	4.852	22.03
0.25-After	11.58	205.40	3.669	5.756
0.25-Before	10.52	114.30	5.854	6.481
0.50-After	8.06	73.33	6.891	3.703
0.50-Before	7.60	60.75	8.055	4.651
0.75-After	7.04	76.68	6.052	4.883
0.75-Before	6.61	42.77	9.84	4.144
0.90-After	5.29	62.70	5.599	3.675
0.90-Before	5.25	45.75	6.811	4.238
Org-After	4.38	57.59	5.889	3.191
Org-Before	4.57	39.73	8.962	4.313

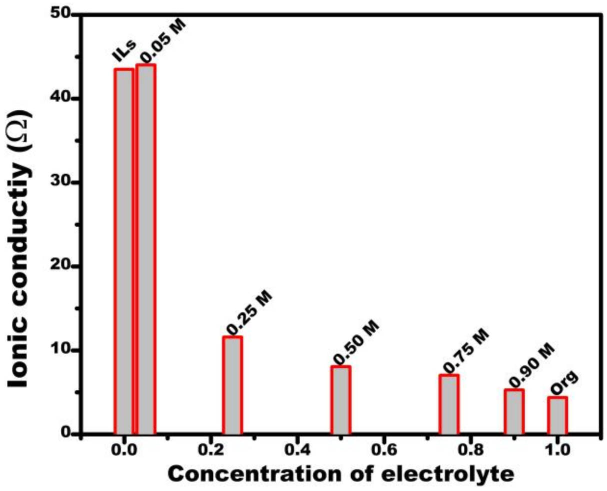

Fig.1 The value of ionic conductivity of neat ionic liquid (ILs), 0.05 M, 0.2 M, 0.5 M, 0.75 M, 0.90 M and neat organic (Org) electrolytes.

The impedance measurement spectra for pure organic electrolyte (EC/DEC) as well as for pure ionic liquid (MPPY) with a concentration of 1M with TFSI-Li, was recorded using the Biologic potentiostat VSP-300. The equivalent circuit[7] to fit impedance data represents the electrolyte resistance R_s in series with the electrode resistances R_{ct}. Because of electrode roughness and other surface phenomena the electrode resistances are combined with a constant phase element that leads to an equivalent circuit of the form R_s (R_1CPE_1) (R_2CPE_2), with R_1 + R_2 equal to R_{ct} seen in Fig. 3. The finally determined lithium electrode resistances (R_s and R_{ct}) and the initial and steady-state current are given in Table 1

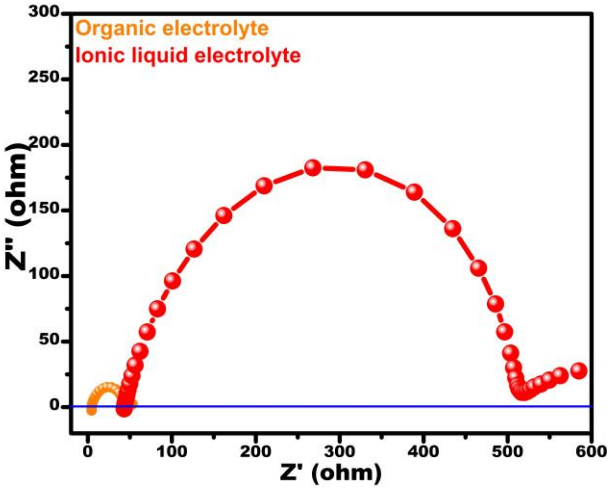

Fig.2 Comparison of Nyquist plot for pure organic and ionic liquid electrolytes.

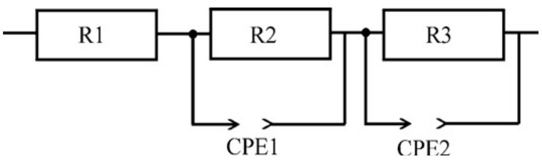

Fig.3. Equivalent circuit of electrode resistances.

3. Conclusion

The results reported in this work demonstrate that, taking advantage of the ionic liquid electrolyte as stability and safety. We have shown the ionic conductivity of the bis (trifluoromethane) sulfonimide lithium salt (TFSI-Li) and ionic liquids (ILs) of 1-methyl-1-propylpyrrolidinum bis (trifluoro-methanesulfonyl) imide (MPPY) with various concentrations of TFSI-Li. TFSI-Li has a high solubility in ILs, due to its relatively low lattice energy). With increasing concentration of TFSI-Li in the binary electrolytes, ionic conductivities decreasing, due to the enhanced columbic interactions upon addition of LiFSI.

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