Ionic Conductivity, Dielectric Behavior, and HATR-FTIR Analysis onto Poly(methyl methacrylate)-Poly(vinyl chloride) Binary Solid Polymer Blend Electrolytes

S. Ramesh, Chiam-Wen Liew, K. Ramesh
Centre for Ionnics University Malaya, Department of Physics, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia
Correspondence to: S. Ramesh (E-mail: rameshsubra@gmail.com)

ABSTRACT: Solid polymer electrolytes comprising blends of poly(vinyl chloride) (PVC) and poly(methyl methacrylate) (PMMA) as host polymers and lithium bis(trifluoromethanesulfonyl)imide (LiTFSI) as dopant salt were prepared by solution-casting technique. The ionic conductivity and dielectric behavior were investigated by using AC-impedance spectroscopy in the temperature range of 298–353 K. The highest ionic conductivity of (1.11 ± 0.09) × 10^{-4} S cm^{-1} is obtained at room temperature. The temperature dependence of ionic conductivity plots showed that these polymer blend electrolytes obey Arrhenius behavior. Conductivity–frequency dependence, dielectric relaxation, and dielectric moduli formalism were also further discussed. Apart from that, the structural characteristic of the polymer blend electrolytes was characterized by means of horizontal attenuated total reflectance–Fourier transform infrared (HATR–FTIR) spectroscopy. HATR–FTIR spectra divulged the interaction between PMMA, PVC, and LiTFSI. © 2012 Wiley Periodicals, Inc. J Appl Polym Sci 000:000–000, 2012

KEYWORDS: PMMA, PVC; dielectric behavior; HATR-FTIR
Received 11 November 2010; accepted 21 February 2012; published online 00 Month 2012
DOI: 10.1002/app.37532

INTRODUCTION
Solid polymer electrolytes (SPEs) manifest wide range of applications in the technology field, ranging from small-scale production of commercial secondary lithium batteries (also known as the rechargeable batteries) to advanced high energy electrochemical devices, such as chemical sensors, fuel cells, electrochromic windows, supercapacitors, analog memory devices, and dye-sensitized solar cells (DSSCs). As for the commercial promises of lithium rechargeable batteries, there is a wide range of application, which ranges from portable electronic and personal communication devices such as laptop, mobile phone, MP3 player, PDA to hybrid electrical vehicle (EV), and start–light-ignition (SLI), which serves as traction power source for electricity.1 SPEs are formed by doping a low lattice energy metal salt in polymer matrix, and the solution is thus dissolved by aprotic solvent. A force had been driven in the development of SPE because of its high automation potential for electrode application, high ambient temperature–ionic conductivity, wide operating temperature range, and low volatility as well as less probability for leaking noncorrosive medium.2,3 In addition, the electrochemical, structural, thermal, photochemical, and chemical stability can be enhanced for SPEs in comparison with conventional liquid electrolyte.

Many approaches have been performed to increase ionic conductivity at ambient temperature, including polymer blending, crosslinking of two different types of polymers, impregnation of inorganic inert fillers, and addition of plasticizer. Among these methods, blending of polymer system has been found to be the most viable technique. Polymer blending not only improves the ionic conductivity but also exhibits good electrical and mechanical properties. Many polymer blend systems have been synthesized and investigated, such as PVA–poly(methyl methacrylate) (PMMA),4 PVC–PMMA,5 PVC–PVA,6 PVC–PMMA,7 poly(vinyl chloride) (PVC)–PEMA,8 PE–PVDF,9 PMMA–PVDF,9,10 and PMMA–PVA12–17. In this study, blending of PMMA and PVC is used. The dipole–dipole interaction between hydrogen and chlorine atoms stiffens the polymer backbone. Hence, PVC acts as a mechanical stiffener in this polymer system.18 PMMA is selected because of its high surface resistance, good compatibility with most of the polymers, excellent interfacial stability toward the lithium electrodes, and high ability to solvate inorganic salts to form complexation between polymer and...