UNIVERSITI TEKNOLOGI MARA

PHYSICAL AND ELECTROCHEMICAL STUDIES OF BIO-BASED CHAIN EXTENDED CATIONIC POLYURETHANE WITH NaTf SALT FOR SOLID POLYMER ELECTROLYTES

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ABSTRACT

Polymer electrolytes are class of materials characterised with high ion concentrations in application of renewable energy devices. Unfortunately, the world is facing a severe shortage of renewable, safe, and environmentally friendly energy resources. Therefore, in this study, a new class of bio-based chain extended polyurethane (modified PU) and cationic polyurethane (PCPU) were synthesized as a polymer host for polymer electrolyte system. The PU samples were synthesized using two different polyols monomer groups ratio of palm kernel oil polyol (PKO-p) to polyethylene glycol (PEG200) as chain extender, while 2-4 'diphenylethylene diisocyanate (MDI) is used as isocyanate group. 1-iodopropane is used as alkyl group to produce cationic PU (PCPU) and sodium triflate (NaTf) is used as a doping salt for preparation of polymer electrolyte. Characterization techniques of GPC, FTIR, XRD, FESEM, TGA, DSC, EIS, transference number (ionic and cationic) and linear sweep voltammetry (LSV) were used to study the properties of the prepared system. The addition of PEG200 into PU increased the molecular weight of modified PU from 14968 g/mol to 66969 g/mol and decreased to 2157 g/mol in PCPU. Formation of urethane linkages (-NCOOH-) of PU were evidenced by Fourier transform infrared (FTIR) spectroscopic analysis with the disappearance of NCO peak and emergence of secondary amine, carbonyl, and ether group. XRD studies showed that the sample PU3 exhibited the largest FWHM at 9.83 with degree of crystallinity of 68 % and for PCPU3, FWHM value is at 9.68 with degree of crystallinity of 68 %. The T_g reduced to 35 ºC for PU3 and 23 ºC for PCPU3 with thermal stability up to up 190 ºC. The ionic conductivity achieved was approximately 1.46×10^{-9} Scm^{-1} for PU3 and 2.97×10^{-9} Scm^{-1} for PCPU3. The addition of 25 wt. % NaTf in PU3 and PCPU3 polymeric system found that the peaks of the functional groups N-H, C=O, C-N and C-O-C were shifted due to the interaction of Na^+ with oxygen atom at ether group. TGA analysis proved that all samples prepared are thermally stable up to 190 º C and the T_g was found to decreased. Ionic conductivity for the PU and cationic PU polymer electrolytes showed optimum ionic conductivity at 25 wt.% NaTf of 3.59×10^{-7} Scm^{-1} for PU3_25 and 1.11×10^{-5} Scm^{-1} for PCPU3_25. The transference number of these electrolytes were found to be 0.40 for PU3_25 and 0.47 for PCPU3_25 with window stability of 2.90 V for PU3_25 and 3.01 V for PCPU3_25.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Over the last three decades, the field of polymer electrolyte (PE), a solid state or quasi solid state electrolyte has attracted worldwide attention due to its practical applications in energy storage components and electrochemical devices (Bao et al., 2018). PEs are formed by inorganic salt dissolution in a host polymer matrix which is polar and maybe classified into several different types as shown in Figure 1.1.

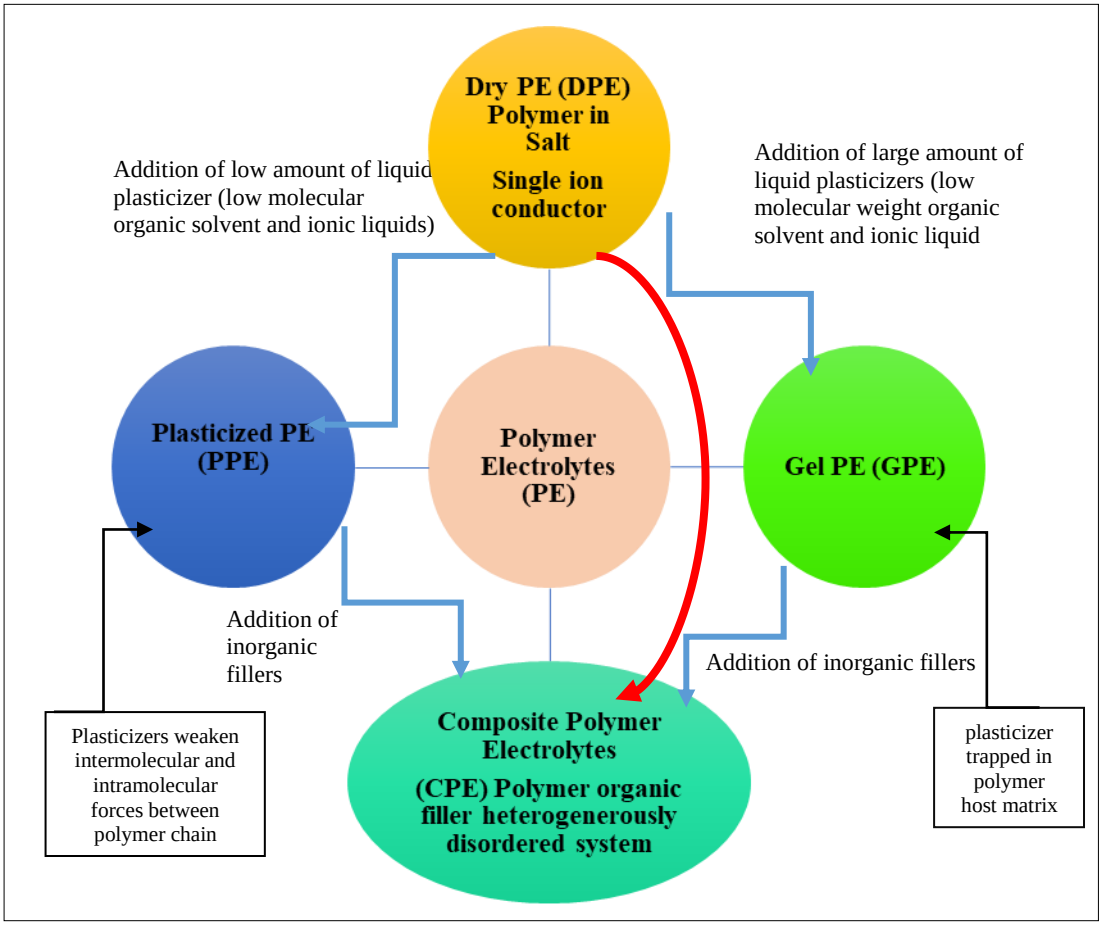

Figure 1.1 Types Of Classic Polymer Electrolytes, Illustrating Relationship Of Dry Polymer Electrolytes (DPE), Plastisized Polymer Electrolytes (PPE), Gel Polymer Electrolytes (GPE) And Composite Polymer Electrolytes (CPE)