THE EFFECT OF CHOLINE CHLORIDE/1,4-BUTANEDIOL DEEP EUTECTIC SOLVENT ON THE STRUCTURAL, MORPHOLOGICAL, THERMAL AND ELECTRICAL PROPERTIES OF PMMA-BASED ELECTROLYTES FILMS

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ABSTRACT

THE EFFECT OF CHOLINE CHLORIDE/1,4-BUTANEDIOL DEEP EUTECTIC SOLVENT ON THE STRUCTURAL, MORPHOLOGICAL AND ELECTRICAL PROPERTIES OF PMMA-BASED ELECTROLYTES FILMS

Previously, the brittleness of PMMA-based polymer electrolyte (PE) films has been successfully improved by the addition of ionic liquid (IL). However, ionic liquid is expensive, requires tedious preparation technique and has toxicity issue. Alternatively, deep eutectic solvent (DES) has been used as the replacement of IL as it is cheaper, highly biodegradable, less toxic and requires simpler synthesis processes. Thus, in this study, deep eutectic solvent (DES) namely Choline Chloride/1,4 Butanediol was incorporated into the PMMA-based PE via solution casting technique. Lithium triflate (LiTf) was also doped into the system to provide additional charge carrier. The effect of various amount of DES towards the structural, morphological, and electrical properties of PMMA-based PE films were determined using Fourier Transform Infrared Spectroscopy (FTIR), optical microscope (OM) and electrochemical impedance spectroscopy (EIS) respectively. Solid, flexible and free-standing film with improved ionic conductivity ($4.5\text{x}10^{-6}$ S cm^{-1}) was successfully obtained by adding 30% of DES into the PMMA/LiTf electrolytes. This was due to the bulky structure of DES, with the amount of 30%, has occupied the space between PMMA chains and hinders the formation of hydrogen bonding. This minimization of hydrogen bonding enables the lithium ion from the salt, LiTf to freely move and improves the ionic conductivity. This can be supported by OM analysis which showed the reduce number of grains related to the amorphousity of the sample. However, the addition 10% DES produced brittle film with drop in ionic conductivity. This is caused by the occurrence of ion multiples and ion aggregates which can be further supported by the increase in the grain number as observed from OM micrograph of PMMADES10. From the FTIR analyses, the interaction of LiTf and DES with the oxygen atoms (coordinating sites) of PMMA were observed.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

A polymer is a large molecule (macromolecule) made up of repeated structural units that are linked by covalent chemical bonds. Basically, polymer is an insulator or unable to conduct electricity. Ionically conducting polymer or polymer electrolyte (PE) can be obtained when inorganic salt is being added into the polymer matrix. In polymer electrolyte system, the function of polymer is as an immobile solvent for the ionic salt. PE, like other type of electrolytes facilitate in the transfer of charge between a cell's anode and cathode. Thus, PEs are used in energy storage devices including batteries, supercapacitors, and fuel cell. Furthermore, PEs are thought to be far safer than liquid electrolytes (LEs), which can leak, corrode, and explode.

PE can be classified into three groups which are gel polymer electrolytes (GPE), composite polymer electrolytes (CPE) and solid polymer electrolytes (SPE). According to Ngai et al. (2016), GPE is a polymer electrolyte that is created by combining a liquid plasticizer (e.g.: polyethylene carbonate (PC), ethylene carbonate (EC), etc.) into the SPE. GPE works well in the ionic transport mechanism, however it has poor mechanical qualities at high ionic conductivity. On the other hand, CPE is