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

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(Muhammad Amir Aiman Bin Sapihudin)

ABSTRACT

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

The brittleness of poly (methyl methacrylate) (PMMA) film has been proven to be improved by the incorporation of ionic liquid (IL). This was due to the large structure of IL that occupied the space between PMMA chain and hindered the formation of hydrogen bonding. However, IL has high cost of starting ingredients and is difficult to synthesis. Hence, to overcome the brittleness of PMMA film, cheaper, less toxic, renewable, and highly biodegradable deep eutectic solvent (DES) was used as the replacement of IL. Thus, the objective of this study is to prepare flexible and free-standing films by adding 10, 20, 30, 40 and 50 wt% DES of choline chloride/ethylene glycol into the PMMA-based polymer via solvent casting technique. The effect of various amount of choline chloride/ethylene glycol on the structural, electrical, and morphological properties of PMMA-based polymer electrolyte films were determined using Fourier transform infrared spectroscopy (FTIR), electrochemical impedance spectroscopy (EIS) and optical microscope (OM) respectively. It was found that the addition of DES into the PMMA system produced brittle films. Only PMMADES20 and PMMADES40 (20 and 40 wt% DES) were obtained as free-standing films despite their brittleness. Due to that, the ionic conductivity decreased to one order of magnitude to 6.87×10^{-10} S cm^{-1} (PMMADES20) and 7.26×10^{-10} S cm^{-1} (PMMADES40) after adding DES if compared to PMMA/LiTf sample (2.23×10^{-9} S cm^{-1}). This can be related with the restriction of the mobility of Li^+ ions due to the formation of ion aggregates from the accumulation of excess DES particles. The accumulated DES particles occurred due to the congested structure of the system that was led by strong interaction between oxygen atoms of PMMA (O-CH_3) with the DES and this was confirmed by FTIR analyses. The congested structure observed via the OM micrograph of PMMADES40 hence further supports this finding. The bulky structure of DES is initially expected to fill the space between PMMA chains, thereby limiting the hydrogen bond formation that causes the structure's brittleness. According to the observation, the DES's bulky structure, on the other hand, accumulated and is unable to prevent the creation of hydrogen bonds between PMMA chains. As a result, this explains why DES incorporation into PMMA/LiTf did not able to produce flexible films. For future study, it is recommended to incorporate lower percentage of DES such as 1, 3, 5 and 7 wt% to avoid the formation of excess DES particle.

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CHAPTER 1

INTRODUCTION

1.1 Background

Liquid electrolytes have been widely used in the construction of numerous types of batteries in recent decades, including lithium batteries, lead-acid accumulators, mercury cells and nickel-cadmium batteries (Winter and Brodd, 2004). The leakage of dangerous liquid and gases is one of the biggest disadvantages of liquid electrolytes (Golodnitsky et al., 2002). To overcome this problem, polymer electrolyte (PE) is widely used as the alternative.

A PE membrane is composed of salts dissolved in a polymer matrix with a high molecular weight. (Ramesh and Lu, 2012). PE have found uses in electrochemical devices such as electrochromic windows, rechargeable batteries, fuel cells, dye-sensitized solar cells and electrical double layer capacitors (Agrawal and Pandey, 2008).

Gel polymer electrolyte (GPE), solid polymer electrolyte (SPE) and composite polymer electrolyte (CPE) are the three types of PE based on their physical standing and constitution (Bloise et al., 2001; Stephan, 2006). GPE is a polymer matrix that has been plasticized or gelled swelled in a liquid electrolyte by the addition of plasticizer (Saikia et al., 2008).