UNIVERSITI TEKNOLOGI MARA

MORPHOLOGICAL, STRUCTURAL, AND ELECTRICAL STUDIES OF BUTYL ESTERS PLASTICIZED POLY(METHYL METHACRYLATE) ELECTROLYTES

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ABSTRACT

Several modifications have been used to overcome the disadvantages of PMMA electrolytes, which are brittle and have low ionic conductivity at room temperature. These modifications include adding filler, blending with other polymers, and adding plasticisers. Plasticizers, for example, have been discovered to improve ionic conductivity. However, they, particularly phthalate plasticisers, pose a number of environmental and health risks. Therefore, In this study, a new series of butyl esters-based plasticizers (BEBPs) were introduced which synthesized from different length of saturated fatty acids such as butyric acid (C4), caprylic acid (C8), lauric acid (C12), myristic acid (C14), palmitic acid (C16), stearic acid (C18). BEBPs were synthesized by esterification reaction between the acids with n-butanol and sulphuric acid as catalyst. PMMA/PPs electrolytes were prepared at various percentages of PP (1% (PEPP1), 3% (PEPP3), 5% (PEPP5), and 7% (PEPP7)) and the solvent casting method was used successfully incorporate non-volatile BEBPs into PMMA electrolytes. All BEBPs include butyl butyrate (PB), butyl caprylate (PC), butyl laurate (PL), butyl myristate (PM), butyl palmitate (PP) and butyl stearate (PS)) were successfully characterized using Fourier transform infrared spectroscopy (FTIR) and nuclear magnetic resonance (NMR) analyses. The important peak of esters was visible at 1283-1281 cm^{-1} in FTIR spectra. Meanwhile, NMR analyses confirmed the presence of a critical peak unique to butyl esters at spectra δ = 3.97- 4.00 ppm. Volatility test was carried out at room temperature shows that PL, PM, PP and PS still presence after 14 days. The intensity of FTIR peak corresponding to C=O and O-CH_3 were decreases as the percentage of PP increased up to 5%, then increases back when 7% of PP was added. EIS result confirmed that the room temperature ionic conductivity of PP plasticized PMMA/PP electrolytes increases with percentages of PP maximum up to 5 % with a value of 3.21×10^{-5} Scm^{-1}. Free-standing and less opaque PEPP1, PEPP3, PEPP5, and PEPP7 films were obtained. Furthermore, SEM analyses reveals that when a higher concentration of PP is added, the white particles probably $LiBF_4$ become smaller and become ordered in PMMA matrix. Interestingly, in optical microscopy (OM) the dark spots dissolved in a brown spot when the percentages of PP added was increased up to 7%. The formation of films demonstrates that the longer the alkyl chain length of BEBPs, the better the surface film. OM and SEM both also confirmed similar observations. The white particles in SEM analyses smaller and ordered at PEPP5. Furthermore, it was also confirmed by OM that the dark spot $LiBF_4$ dissolved at longer alkyl chain BEBPs. The intensity of the C=O and O-CH_3 groups of PMMA was found to be the lowest at PEPP5 compared to the other BEBPs, indicating that more free ions occurred than ion pairs. According to EIS, PEPP5 has the highest ionic conductivity compared to other BEBPs, which can increase to 20.22×10^{-5} Scm^{-1} at 80°C. It was discovered that PEPP5 has the best properties for enhancing PMMA/BEBPs electrolytes.

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