

UNIVERSITI TEKNOLOGI MARA

**ELECTRICAL AND PHYSICAL
STUDIES OF POLYMER
ELECTROLYTE BASED ON
METHYLGRAFTED NATURAL
RUBBER (MG30)**

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of the requirements for the degree of
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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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ABSTRACT

This dissertation focuses on the preparation and characterization of MG30-salt complexes and plasticized MG30-salt complexes. In the present study, 30% poly(methylmethacrylate) grafted natural rubber (MG30) as polymer host, ammonium trifluoromethanesulfonate ($\text{NH}_4\text{CF}_3\text{SO}_3$) as doping salt and ethylene carbonate (EC) as plasticizer were used in the preparation of solid polymer electrolytes (SPEs) and gel polymer electrolytes (GPEs). The SPEs and GPEs were prepared by the solution cast technique with different weight percent (wt.%) of $\text{NH}_4\text{CF}_3\text{SO}_3$ and EC. The conductivity of the samples were characterized by the impedance spectroscopy in the frequency range between 100Hz and 1MHz. Highest ionic conductivity of SPE containing 35 wt.% $\text{NH}_4\text{CF}_3\text{SO}_3$ in MG30: $\text{NH}_4\text{CF}_3\text{SO}_3$ was $1.94 \times 10^{-4} \text{ Scm}^{-1}$. Further enhancement of ionic conductivity obtained with addition of plasticizer into SPE was $9.61 \times 10^{-4} \text{ Scm}^{-1}$ at the composition of 26:14:60 wt.% for MG30: $\text{NH}_4\text{CF}_3\text{SO}_3$:EC. ATR-FTIR spectroscopy justify the interactions between polymer and salt primarily due to the C=O of MG30 and NH_4^+ of salt. The shifting of the carbonyl peak C=O of MG30 at 1728cm^{-1} to the lower wavenumber indicates coordination takes place between ammonium cation and C=O to form $\text{NH}_4^+ \leftarrow \text{O}=\text{C}$ interaction. FTIR studies also confirm the addition of plasticizer just penetrated in between polymeric chain and create more free volume by reducing the polymer chain cross linking without perturbing the complexation of polymer-salt. XRD analysis confirmed the formation of polymer-salt complexes with the decreasing of peak intensity at $2\theta=44.3^\circ$ and 55.6° of MG30 upon the addition of salt and plasticizer content. Besides that, XRD spectra analysis demonstrated the incorporation of plasticizer has reduced the crystallinity of MG30- $\text{NH}_4\text{CF}_3\text{SO}_3$ promotes to ion migration easily hence lead to the ionic conductivity enhancement. The differential scanning calorimetry (DSC) analysis found the introduction of EC into SPE has decreased the T_g value suggesting that EC have disturbed the crystalline domain of polymer thus reduced the degree of crystallinity of the polymer electrolytes. The energy band gap (E_g) found to decrease with increasing of plasticizer and salt content by UV-Visible studies. The dopant (salt and plasticizer) considered as defect in polymer which affects the optical band gap. The window stability of SPE was observed around 2.2V whereas the window stability of GPE was around 2.7V.

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