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STRUCTURAL, ELECTRICAL AND ION TRANSPORT PROPERTIES OF NATURAL POLYMER BASED CARBOXYLMETHYL CELLULOSE DOPED AMMONIUM CARBONATE

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School : School of Fundamental Science

Conducting solid polymer electrolytes (SPE) has garnered much attention since it possesses great advantages especially polymer derived from natural sources. Current work aims are to develop and characterize SPE films formed from carboxymethyl cellulose (CMC) as the polymer host and doped with varying ammonium carbonate ($(NH_4)_2CO_3$) concentration (1 wt.% - 11 wt.%) through solution casting techniques. The CMC-$(NH_4)_2CO_3$ SPE were tested and analyzed by numerical analysis to determine the effect of $(NH_4)_2CO_3$ in the CMC-$(NH_4)_2CO_3$ SPE system. The CMC-$(NH_4)_2CO_3$ SPE films structural analysis was conducted through X-ray diffractometer (XRD) for phase identification and Fourier-transform infrared (FTIR) for complexation confirmation. All CMC-$(NH_4)_2CO_3$ SPE films show highly amorphous content with crystallite size ranging between 0.96 nm and 1.37 nm. IR vibrational analysis shows interaction mainly occur at 1591 cm^{-1} wavenumber due to C=O of carboxyl group of CMC interaction with H^+ of ammonium carbonate. The ionic

conductivity (σ) of CMC-NH_4CO_3 SPE value increase from 9.33 x 10^{-9} S cm^{-1} for undoped SPE and achieved highest value of 7.71 × 10^{-6} S cm^{-1} for sample doped with 7 wt.% concentration of ammonium carbonate. When subjected to temperature, the SPE films ionic conductivity value shows a great dependence towards Arrhenius behavior (R^2~1) where the samples are thermally activated. It is found that, the activation energy (E_a) have direct effect on ionic conductivity where the activation energy decreases with increasing ionic conductivity. The electrical behavior of the CMC-$(NH_4)_2CO_3$ SPE system shows it is attributed to conductivity relaxation process and influenced by both frequency and temperature. The ionic conductivity enhancement is found to be dominantly dependence on ionic mobility (μ) and diffusion coefficient (D) compared to the number of mobile ions (η). Via dc polarization technique, the mobile ionic species is further proven to be predominantly influence by proton (H^+) of which the ions conduction mechanism follow the quantum mechanical tunneling (QMT) conduction model as verified through Jonscher's universal power law relation.

Abstrak tesis dikemukakan kepada senat universiti malaysia terengganu sebagai memenuhi keperluan untuk ijazah sarjana sains.

PENCIRIAN STRUKTUR, ELEKTRIKAL DAN SIFAT PERGERAKAN ION POLIMER SEMULAJADI KARBOSILMETIL SELULOSA DIDOP DENGAN AMMONIUM KARBONAT

MOHD IBNU HAIKAL BIN AHMAD SOHAIMY

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Polimer konduktif pepejal (SPE) telah menarik banyak perhatian memandangkan ia mempunyai banyak kelebihan terutamanya jika polimer tersebut dihasilkan daripada bahan semulajadi. Kajian ini bertujuan untuk menghasilkan dan mencirikan SPE yang diperbuat daripada karbosilmetil selulosa (CMC) sebagai perumah dan didopkan dengan pelbagai kepekatan ammonium karbonat (1 wt.% - 11 wt.%) melalui teknik tebaran larutan. CMC-$(NH_4)_2CO_3$ SPE diuji dan dianalisa melalui analisis berangka untuk menentukan kesan ammonium karbonat di dalam sistem CMC-$(NH_4)_2CO_3$ SPE. Analisis struktur telah dilakukan dengan menggunakan teknik belauan sinar-X (XRD) untuk pengenalan fasa serta teknik Fourier Penukar Inframerah (FTIR) bagi pencirian pengkompleksan. Kesemua sistem CMC-$(NH_4)_2CO_3$ SPE menunjukkan sifat amorfus yang tinggi dengan saiz kristal di antara 0.96 nm and 1.37 nm. Analisis gelombang IR menunjukkan interaksi tertumpu pada nombor gelombang 1591 cm^{-1} disebabkan oleh interaksi di antara C=O kumpulan karboksil CMC dengan H^+ daripada ammonium karbonat. Nilai

kekonduksian berion (σ) pada suhu bilik meningkat daripada 9.33 x 10^{-9} S cm^{-1} bagi SPE yang tidak didop dan mencapai nilai tertinggi 7.71 × 10^{-6} S cm^{-1} bagi sampel didop dengan 7 wt.% kepekatan ammonium karbonat. Apabila diuji pada suhu yang lebih tinggi, nilai kekonduksian berion filem-filem SPE menunjukkan kebersandaran terhadap sifat Arrhenius (R^2~1) di mana ia adalah teraktif oleh suhu. Tenaga pengaktifan (E_a) didapati mempunyai kesan secara langsung terhadap kekonduksian berion di mana tenaga pengaktifan menurun dengan peningkatan kekonduksian berion. Sifat elektrikal sistem CMC-$(NH_4)_2CO_3$ SPE menunjukkan ia disebabkan oleh proses kekonduksian rehat dan dipengaruhi oleh frekuensi dan suhu. Peningkatan kekonduksian berion bergantung secara dominan terhadap kelincahan ion (μ) dan pekali peresapan (D) berbanding jumlah ion yang bergerak (η). Spesis ion bergerak telah dibuktikan melalui teknik pengkutuban *dc*, di mana sebahagian besarnya adalah disebabkan oleh proton (H^+) dan mekanisma kekonduksian ion mematuhi model penerowongan mekanik kuantum (QMT) yang disahkan menerusi hubungan hukum kuasa sejagat Jonscher.