UNIVERSITI TEKNOLOGI MARA

POLYMER ELECTROLYTES BASED ON HEXANOYL AND LAUROYL CHITOSANS FOR APPLICATION IN DYE- SENSITIZED SOLAR CELLS

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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 results 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 degree or qualification.

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ABSTRACT

Hexanoyl chitosan and lauroyl chitosan were prepared by acyl modification of chitosan. Hexanoyl chitosan and lauroyl chitosan were characterized by FTIR, XRD and NMR, in comparison to chitosan. Films of hexanoyl chitosan and lauroyl chitosan-based polymer electrolytes incorporated with different weight concentrations of sodium iodide (NaI) were prepared using solution casting technique. Fourier transform infrared (FTIR) and differential scanning calorimetry (DSC) results suggested that NaI interacted with both hexanoyl chitosan and lauroyl chitosan. Maximum conductivities of 1.3 x 10^{-6} and 1.1 x 10^{-8} S cm^{-1} are achieved for hexanoyl chitosan and lauroyl chitosan, respectively. Higher conductivity in hexanoyl chitosan is attributed to the higher number of free ions and higher mobility of ions, as evidence from impedance spectroscopy. Hexanoyl chitosan were then blended with poly (vinyl chloride) (PVC). Differential scanning calorimetry results reveal that i) hexanoyl chitosan and PVC are immiscible, and ii) preferential interaction of NaI with hexanoyl chitosan than PVC. X-ray diffraction (XRD) results show that presence of PVC hinders the crystallinity of hexanoyl chitosan and sample with lower crystallinity exhibits higher conductivity. The maximum conductivities acquired for neat hexanoyl chitosan, PVC and the blend system are 1.3 x 10^{-6}, 2.9 x 10^{-8} and 1.5 x 10^{-5} S cm^{-1}, respectively. Incorporation of ionic liquid, 1-methyl-3-propyl imidazolium iodide (MPImI) to the highest conducting blend electrolyte system further increased the ionic conductivity. The highest room temperature ionic conductivity of 1.3 x 10^{-4} S cm^{-1} is acheived by hexanoyl chitosan/PVC-NaI containing 8 wt.% MPImI, which is one order of magnitude higher than ionic liquid free electrolyte system. The performance of dye-sensitized solar cells (DSSCs) employing hexanoyl chitosan/PVC-based electrolytes was investigated with respect to MPImI content. The addition of 8 wt.% MPImI to the cell of hexanoyl chitosan/PVC-NaI increases the efficiency up to 4.55% and J_{sc} up to 10.34 mA cm^{-2}. The performance of DSSCs is further improved by introducing 4-tert-butylpyridine (TBP) and guanidinium thiocyanate (GuNCS) to the TiO_2 photoanode. This further increases the η to 7.38 % and J_{sc} to 17.75 mA cm^{-2}.

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