STUDIES ON A CONDUCTING BIOPOLYMER FILM FROM A BLACK TIGER (*PENAEUS MONODON*) PRAWN SHELL WASTE IN MYANMAR

PhD (DISSERTATION)

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ABSTRACT

The solid polymer electrolyte has no fluidity, thereby enabling laminated thin packages and increased capacity, it helps making devices small, light weight and flexible. Consequently, a conducting biopolymer electrolyte film has been prepared from a renewable resource chitosan and studied on its characterization.

The investigation on basic technical conditions for production of chitosan from Black Tiger Prawn (*Penaeus monodon*) shell waste in Myanmar was studied. The criteria condition for chitosan production was achieved by using 50 % (w/v) sodium hydroxide solution under nitrogen atmosphere at 120 °C with intermitted washing during deacetylation process. The chitin and chitosan products were identified by solubility, FT-IR spectroscopy, ^{13}C CP-MAS NMR, and elemental analysis. According to the FT-IR spectra, the absorption band nearly 1630 cm^{-1} is significantly downward in chitosan spectrum, which showed the removal of acetyl group in chitin. The ^{13}C CP-MAS NMR technique carried out structure identification and degree of deacetylation (DDA). It obviously indicated that the chemical shift of chitosan product agrees with the literature values and the degree of deacetylation is ~100 %DDA. Moreover, the atomic ratios of carbon and nitrogen for chitin and chitosan product were found to be 8:1 and 6:1, which is consistent with monomeric units of chitin ($C_8H_{13}NO_5$) and chitosan ($C_6H_{11}NO_4$) according to the elemental analysis. The average molecular weight of chitosan product was measured by means of gel permeation chromatography (GPC), M_w=9.5 x 10^5 Da, M_n=2.2 x 10^5 Da, M_p=5.0 x 10^5 Da, and polydispersity is 4.2.The fibril structure of prepared chitin and chitosan product was recorded by scanning electron microscopy (SEM). Therefore, the quality grade chitosan can be produced from this study due to the above factors. The chitosan based conducting

biopolymer films were prepared by casting and solvent evaporating technique. Sulphuric acid was chosen as the cross-linking agent. It enhanced conduction pathway in cross-linked chitosan films. All prepared chitosan films were pale yellow colour, transparent, and smooth. The flexible and mechanically strong conducting chitosan film was achieved. SEM micrographs clearly showed continuous and homogeneous surface morphology, and the layer by layer or strata formation on the cut-edge morphology of conducting chitosan film. According to the XRD diffraction pattern, high molecular weight of chitin product exhibited high crystallinity, chitosan product indicates the hydrated crystal nature, but the prepared uncross-linked chitosan film and cross-linked chitosan film indicate significantly lower in crystallinity which prove of the amorphous characteristics. The DSC thermogram profiles clearly observed that uncross-liked chitosan film displayed exothermal polymer decomposition while the cross-linked chitosan films mainly showed endothermic characteristics above the temperature 200 °C. The characteristic degradation of ionic interaction between the host polymer chitosan and cross-linking agent sulphuric acid was significantly found in the TG-DTG and DSC analysis. The electrical conductivity of conducting chitosan films depends on the concentration of chitosan and cross-linking reagent. Its concentration of 2.0 %(w/w) gives the highest electrical conductivity among the chitosan film doped with other concentrations of sulphuric acid. The electrical conductivity of cross-linked chitosan films were in the order of 10^{-7} to 10^{-5} S cm^{-1}, which is in the range of semi-conductor category, *i.e.*, 10^{-8} to 10^{-2} S cm^{-1}. These results showed that prepared cross-linked chitosan films can be used as solid polymer electrolyte film to fabricate solid state electrochemical cells.

Keywords: *chitosan, ^{13}C CP MAS NMR, GPC, XRD, SEM, conducting chitosan biopolymer film, solid-state studies, mechanical properties, thermal properties, electrical conductivities*