Green solid electrolyte for electrochemical devices

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Researchers from the Faculty of Engineering of Universiti Teknologi MARA (UiTM), Malaysia, have studied the capability of new polymers derived from potato starch as insulators which do not show any remarkable electro activity.

The majority of all polymers are insulators which do not show any remarkable electro activity. In the past, researchers have found out how to obtain a conducting polymer by the introduction of salts, plasticizer and nanofillers. Uniform dispersion of plasticizer and fillers in salt-polymer matrices creates a class of novel materials exhibiting superior electrical and mechanical properties which are suitable to replace many existing materials such as those for engineering applications and in electrochemical devices.

Novel material which consists of starch is one of the most common renewable and biodegradable polymers deposited as granules in plants that are found abundantly in our country. It is composed of repeating amylose and amylopectin.

In this research work, potato starch was used as the polymer host because it has a better morphology in comparison to other starch. Physically, it appeared as a soft, flexible film with high conductivity compared to corn starch. Furthermore, potato starch is presently applied in the industrial field for coatings and sizing in paper, textiles and carpets as binders and adhesives, absorbents and encapsulates. The starch-based film is reported to exhibit good mechanical properties.

In addition, the dry, thin film of starch could also be prepared easily. Ammonium salt was chosen because it does not have a high tendency to break the starch. The thin clear films of potato starch were prepared by solution casting technique. A certain amount of potato starch (Sigma-Aldrich) was weighed and dissolved in 50ml of acetic acid in a 100mL beaker and left to be stirred for 20 minutes at a certain temperature. Once the cloudy solution turns clear, it is cooled to room temperature. The solution is then doped with various amounts of ammonium salts. Later, these dry thin films were characterized via Impedance Spectroscopy, Fourier Transform Infrared (FTIR), X-Ray Diffraction (XRD), and Scanning Electron Microscope (SEM).

Based on the impedance results, the conductivity of starch is low as there are no mobile ions within the sample. The incorporation of salt increased the conductivity gradually. The higher the concentration of the ammonium salt, the higher the density number of mobile ions. But if the salt concentration is too high, it could increase the influence of the ion pairs and higher ion aggregation, which can reduce the overall mobility and degree of freedom, decreasing the conductivity. FTIR measurement was used to determine the interactions between salt and the polymer host.

In the present work, FTIR spectroscopy was recorded using a Spotlight 400 Perkin-Elmer spectrometer in the wavenumber range of 450-4000 cm_1. The FTIR spectra indicates that the complexation between starch and ammonium salt has occurred. Upon higher concentration of the salt, the hydroxyl band shifted to a higher wavenumber, perhaps due to the fact that either the excess salt did not dissociate or the ions recombine to form a neutral ion pair which decreases the number of ions.

From the x-ray diffractogram, three crystalline peaks are observe. The pure starch film shows a semi-crystalline state due to the presence of both sharp and diffuse diffraction peaks. The fraction of amorphous

phase and the charge carriers increase simultaneously with increasing ion concentration. The optimum composition of the green solid electrolyte has the potential to be used as solid electrolyte in electrical devices since it shows maximum conductivity of 10-3 and serve as an ionic conductor.

Provided by Universiti Teknologi MARA (UiTM)