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Solid-Like Electrolyte Based on Cellulosic Biomass Materials for Cost Effective and Eco-Friendly Lithium Ion Batteries Function as a Sustainable Energy Source

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Abstract

The demand for the sustainable energy sources has increased due to the environmental issues, durability and cost. Lithium ion rechargeable batteries (LiBs) are widely known as a renewable energy source. LiBs can be converted to effective sustainable energy sources when they are modified to acquire the criterias of sustainable energy sources other than rechargeability. In the present, there is an inclination to develop all-solid state and solid-like electrolytes for LiBs due to the environmental and safety issues resulted by liquid electrolytes. In this work, an experiment was carried out to design a lithium ion battery using a solid-like electrolyte based on cellulosic biomass. Cellulosic biomass is very abundant, low cost and eco-friendly. Cellulose is a crucial extractable material of cellulosic biomass and carboxymethyl cellulose can be synthesized from cellulose. In here, one component of the electrolyte synthesized is lithium dichlorocarboxymethyl cellulose (LiCMC) using cellulose, LiOH and trichloroacetic acid. Tricholoacetic acid can be extracted from disinfected byproducts in water. LiCMC has various advantages over typical sodium carboxymethyl cellulose. LiCMC has additional chlorine atoms and lithium ions which directly promote the segmental motion diffusion of lithium ions. The prepared LiCMC was crosslinked with β-cyclodextrin (BCD) using citric acid. In here, BCD is very efficient because it is environmentally friendly and its cavities enhance the lithium ion conduction. Another component in this electrolyte is LiCMC grafted mesoporous silica (MS). The cavities of MS enhance the lithium ion conductivity and the robustness of MS improves the durability of the battery. In the preparation of the electrolyte, citric acid cross linked LiCMC-BCD and LiCMC grafted MS were incorporated together. The resulted hydrogel was dipped in LiCl aqueous solution and then it was used as the electrolyte. Graphite/graphene oxide (GO) composite was used as the anode and Cobalt oxide-GO hydrogel was used as the cathode of the prepared cell. The performance of the assembled cell was analyzed using charge-discharge curves. The assembled cell showed an initial current density of 1.5 mA cm^{-2} and maximum current density of 4.5 mA cm^{-2} in charging and initial current density of 0.90 mA cm^{-2} and minimum current density of 0.20 mA cm^{-2} in discharging. The synthesized materials mentioned in above were analyzed using FTIR-ATR data. The eco-friendliness, cost effectiveness of the materials chosen in cell preparation and the desirable cell performance induce the viability to develop LiBs as sustainable energy sources.

Keywords: Sustainable energy sources, Cellulosic biomass, Solid-like electrolytes, Lithium dichlorocarboxymethyl cellulose, β-cyclodextrin