i TECH MAG

DOI: http://doi.org/10.26480/itechmag.02.2020.06.07

INWASCON

ISSN: 2710-5873 (Online)
CODEN: ITMNBH

SHORT COMMUNICATION

SYNTHESIS AND CHARACTERIZATION OF METHYLCELLULOSE COMPOSITE MEMBRANE

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ARTICLE DETAILS

Article History:

Received 20 January 2020
Accepted 22 February 2020
Available online 10 March 2020

ABSTRACT

Long-life, environmentally friendly, low-cost reliable batteries are today urgently requested to meet some crucial demands of our modern society. The current battery technology containing liquid electrolyte which is hazardous and harmful when leaking make it inappropriate for longer applications in electrochemical devices. Thus, in this study, Methylcellulose (MC) was chosen as host in anionic conducting SPE due to its low cost, renewable resources, biodegradable and environmentally friendly and doped with Potassium Hydroxide (KOH). The study was conducted by using casting method as it is the most appropriate technique due to its simplicity and low cost. Methylcellulose (MC) as the host was doped with different weight percentage (wt%) of Potassium Hydroxide (KOH) to fabricate SPEs. The result shows the adding of KOH onto MC was significantly enhanced the physical properties of SPEs. The loading of 0.8g MC with 50% KOH yield the highest conductivity at 2.5774 x 10-6Sm-1at room temperature. From this study, the finding proved that solid polymer electrolyte (SPE) using Methylcellulose (MC) as a proton receiver and Potassium Hydroxide (KOH), dopant salt and filler is a good alternative to replace the commercial and existing electrolyte battery.

KEYWORDS

Methylcellulose, Solid Polymer Electrolyte, Conductivity.

1. INTRODUCTION

For these past years, the electrochemical power was gained from liquid electrolyte. Even though, liquid electrolyte possesses high ion conductivity, it is also creating a few setbacks such as leakage, reaction with electrode, poor electrochemical stability, yet make it inappropriate for longer applications in electrochemical devices. Thereby, the solid polymer electrolytes (SPE) research field was greatly booming due to its excellent mechanical and thermal stability and high ionic conductivity. Recently, electrochemical energy storage plays a significant role in mobile wireless technology such as tablet, mobile phones, medical electronic devices and even toys. In these modern technologies, such devices urgently demand for long life, environmental friendly, low cost, reliable and rechargeable batteries with higher specific energy density (Scrosati, 2000). The researchers found polymer electrolytes (PE) have remarkable potential to replace the liquid electrolyte, especially in the applications of batteries, sensors, fuel cells and other electrochemical devices. Moreover, the installation of PE in devices take up smaller space, compact and lighter mass. Generally, PE can be classified into two main group, namely SPE and gel polymer electrolytes (GPE). Compare to other types of PE, SPEhave a very limited or problem in leakage or pressure distortion to be studied thoroughly in this research (Avellaneda et al., 2017).

Thus, biopolymers such as cellulose, methylcellulose (MC), rubber, chitosan and tapioca starch are favorable due to their abundance in nature, very low cost and principally biodegradation properties. Among the natural polymers, methylcellulose has been chosen because of excellent film forming ability compare to others (Lin et al., 2007). Thereby, this study is conducted to propose new biodegradable and low cost SPE with MC. Furthermore, Potassium Hydroxide will be used as a filler to enhance the SPE conductivity.

2. MATERIAL AND METHODS

The methodology can be divided into two parts. The first part composed a variation of weight (0.8g, 1g, 1.4g, 1.6g, 1.8g, 1.2g and 2g) of pure MC solution in order the determine the highest conductivity pure MC solution. Then, a different percentage of KOH solution (11% to 56%) were added into highest conductivity pure MC solutions. The characterization of MC membrane doping with KOH were analysed using EIS for conductivity, water uptake and membrane swelling rate.

3. RESULTS AND DISCUSSION

Figure 1 illustrated the ionic conductivity of pure mc samples. Pure MC shows the highest conductivity obtained for sample 0.8MC was at value 7.49 x 10^{-8} Sm^{-1}. Then, 0.8MC was chosen for doped with KOH for further experiment.

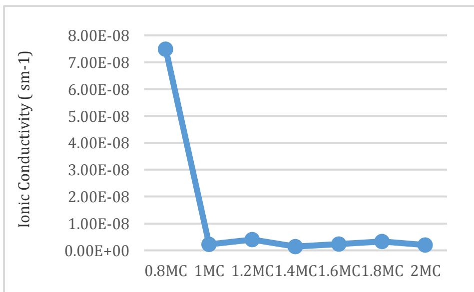

Figure 1: Ionic conductivity of pure MC

Cite the Article: Wan Intan Sofia W. Kamaruddin, Suhaila Abdullah, Nurul Aniyyah Mohd Shoberi, Norazlina Hashim, Nabihah Abdullah, Rabiatul Manisah Mohamed (2020). Synthesis And Characterization Of Methylcellulose Composite Membrane. *i TECH MAG, Vol 2: 06-07*

Figure 2 showed the results of water uptake test for different composition of samples. As for the observation, the wt-% of water uptake fluctuates as the concentration of KOH increase. The highest water uptake is for pure MC (0.8g and 1.4g). The lowest water uptake is for 0.8MC_KOH. The result clearly shows the addition loading of KOH will decrease the water permeability. But in this case, the best water uptake is 0.8MC_50KOH. Cause, for the membrane water uptake cannot be to dry and not too wet. If the membrane too wet, it can cause flooding and can damage the cathode side.

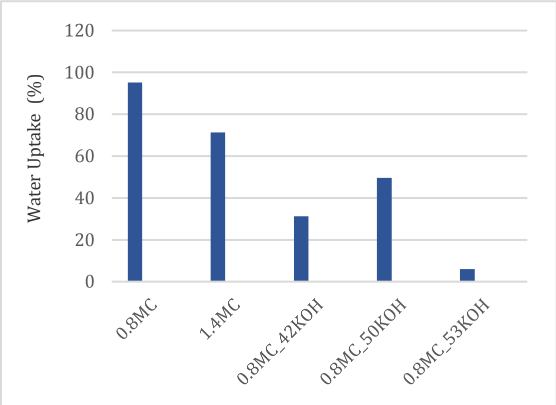

Figure 2: The water uptake test (%) of MC-KOH

The swelling properties is the dimensional change of SPEs for pure MC and MC-KOH as depicted in Figure 3. The ability to swell is an important property of SPEs. Understanding of swelling behavior is important on the thoughtful of ion transfer inside the membrane and microstructure of the SPEs. Figure 3 shows the highest swelling rate occured in pure 1.4MC and 0.8MC_42KOH. The result shown the increasing of KOH loading will decrease the swelling rate. The swelling properties result obviously correlated with the water uptake findings as the dimensional change of the SPEs depends on water sorption (Duan et al., 2013).

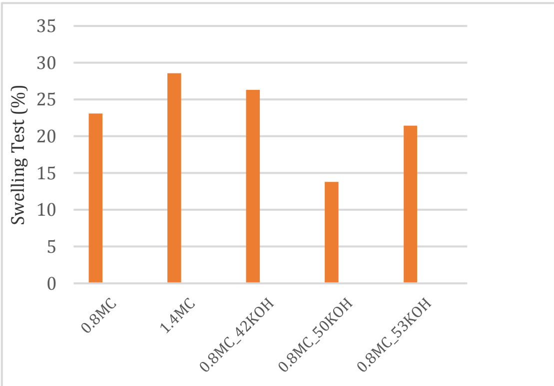

Figure 3: The swelling test (%) for MC-KOH

Figure 4 showed the conductivity of the electrolyte. It is showed that the increase the weight percentage of KOH the increase the conductivity of sample. Pure MC shows the lowest conductivity either for 0.8MC or 1.4MC. The highest conductivity obtained for sample 0.8MC_50KOH was at value 2.58 x 10^{-4} Sm^{-1}. This condition of wt% of KOH is comparable with the result above, because the increasing numbers of mobile ions lead to conductivity enhancement. The increasing amount of MC will increase the membrane porosity that enhance KOH flux (Nadour et al., 2016).

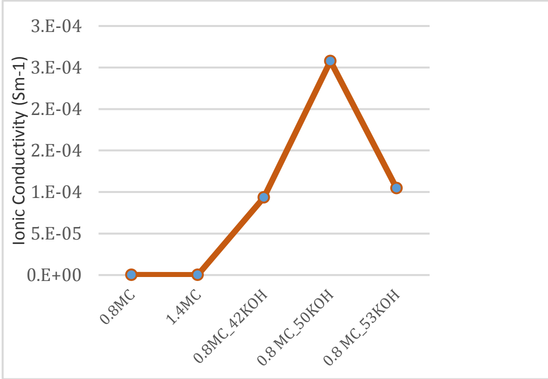

Figure 4: Result for ionic conductivity test Sm^{-1} of MC-KOH

4. Conclusions

The development of solid polymer electrolyte (SPE) membrane using methylcellulose (MC) with potassium hydroxide (KOH) were prepared using casting method and the result can be observed as transparent thin film membrane. The study found the sample with loading 0.8MC_50KOH poses the best physical properties with the highest ionic conductivity value 2.58 x 10-4 Sm-1. The 0.8MC_50KOH SPEs have good stability as the swelling rate is very low. Base on the findings, the amount of generated conductivity still poor and cannot be commercialized compare to existing battery. However, it is proven that the combination of Methylcellulose (MC) with Potassium Hydroxide (KOH) have the potential to be starting point on developing polymer electrolyte (PE) and the be used as solid polymer electrolyte (SPE). The low-cost MC-KOH SPEs have great potential for further exploration to replace the commercial and existing electrolyte battery.

Acknowledgment

This research is fully supported by FRGS/1/2018/TK10/TATI/03/2,.The authors fully acknowledged Ministry of Higher Education (MOHE) and TATI University college for the approved fund which makes this important research viable and effective.

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