Preparation of Poly(vinyl alcohol)/Poly(ethylene oxide) Membranes Using Zinc Oxide as Filler for Solid Electrolyte Applications in Zn-air Battery

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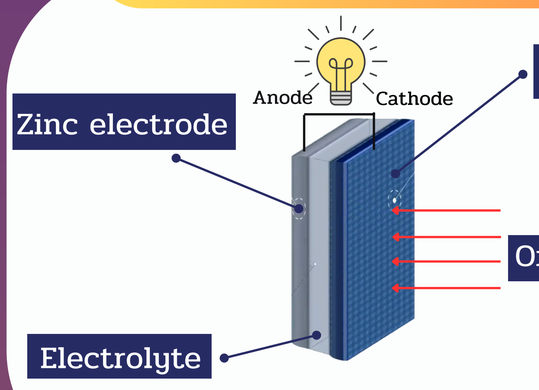
ABSTRACT

In this study, ion-conducting alkaline solid polymer electrolyte membranes (ASPE) were prepared from a poly(vinyl alcohol)/poly(ethylene oxide) blend in a mass ratio of 9:1 (PVA:PEO). The PVA cross-linking with glutaraldehyde and the addition of zinc oxide filler was studied. The prepared membranes were immersed in 7 M KOH solution prior to investigating their physicochemical property. Impedance measurement revealed that the highest ionic conductivity achieved was 4.2 x 10^{-2} S/cm for PVA/PEO/8 wt% ZnO at room temperature. Fourier transform infrared (FTIR) spectroscopy confirmed the chemical interaction between glutaraldehyde (GA) and PVA/PEO. This cross-linking enhances the mechanical strength and stability to alkaline solution of the membrane, ensuring improved durability and resistance to structural deformation under operational conditions. Scanning electron microscopy (SEM) images revealed that the distribution of ZnO in the matrix was observed, but some agglomeration occurred in certain areas. This dispersion contributed to the formation of a porous structure, facilitating ion transport and improving the overall performance of the membrane. The uniform distribution of ZnO also played a crucial role in enhancing the mechanical stability and electrochemical properties of the polymer electrolyte membrane.

INTRODUCTION



Cathode $O_2 + 2H_2O + 4e^- \longleftrightarrow 4OH^-$

Anode $Zn^{2+} + 4OH^- \longleftrightarrow Zn(OH)_4^{2-}$

$ZnO \longrightarrow Zn^{2+} + 2e^-$

- Low Cost and Readily Available Materials
- High Energy Density
- Safetu and Environmentallu Friendlu

OBJECTIVES

- To study the electrolyte conductivity, energy storage capability, and mechanical strength of PEO/PVA/ZnO composite electrolyte at various content of ZnO.

EXPERIMENTAL

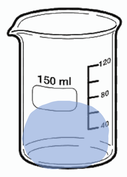
PVA 7.2 g

PEO 0.8 g

ZnO (2,4,6,8 %wt)

Pour into glass petri dishes

Heat and Stir at 80 °C



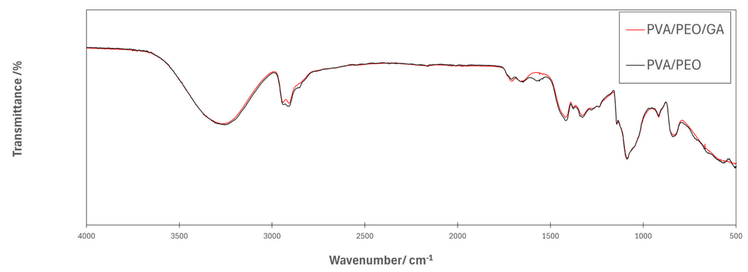
DI Water 57 g

Hot Air Dry at 30 °C for 24 hr

Membrane

RESULTS & DISCUSSION

FTIR



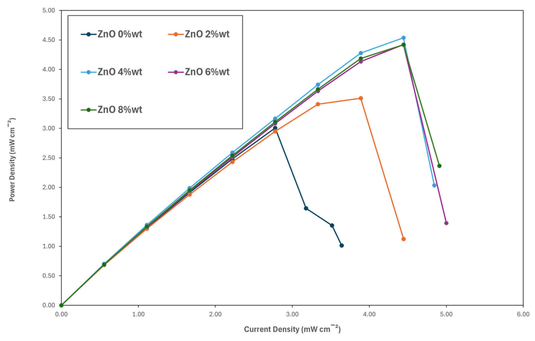
Fourier transform infrared (FTIR) spectroscopy confirmed the chemical interaction between glutaraldehyde (GA) and PVA/PEO.

SEM

PVA/PEO/ZnO 2% | PVA/PEO/ZnO 4% | PVA/PEO/ZnO 6% | PVA/PEO/ZnO 8%

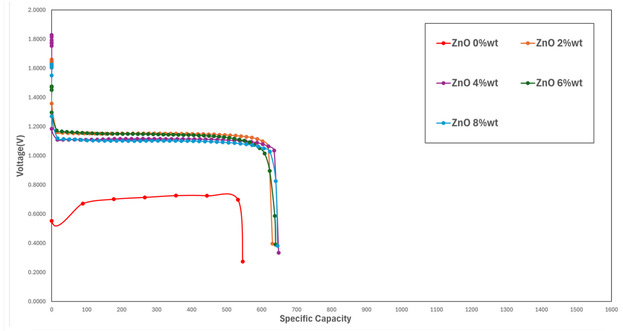
The SEM images show the distribution of ZnO in the matrix but some agglomeration occurs in certain areas.

Power Density



The PVA/PEO with 4% ZnO exhibits the highest power density.

Discharge



The PVA/PEO/ZnO 4% membrane exhibits the highest specific capacity while ZnO improves voltage stability during discharge.

CONCLUSION

- The alkaline composite polymer electrolyte composed of PEO/PVA/ZnO shows great potential for use in Zn-air batteries due to its good ionic conductivity and excellent electrochemical stability.

REFERENCE

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- Mokhtar, Marliyana, Edy Herianto Majlan, Azizan Ahmad, Siti Masrinda Tasirin, and Wan Ramli Wan Daud. 2018. “Effect of ZnO Filler on PVA-Alkaline Solid Polymer Electrolyte for Aluminum-Air Battery Applications.” Journal of the Electrochemical Society 165 (11): A2483–A92.