Polyvinyl alcohol (PVA) and sulfonated polyetheretherketone (SPEEK) anion exchange membrane for fuel cell

H LUO, M MODIBEDI, T RAMULIFHO AND M MATHE
CSIR Built Environment, PO Box 395, Pretoria, 0001, South Africa
Email: hluo@csir.co.za – www.csir.co.za

INTRODUCTION

Fuel cells are well-known electric generating devices which have higher energy conversion efficiency than heat engines and less exhaustion of carbon dioxide (CO_2)[1].

There are several types of fuel cells. Solid oxide fuel cells (SOFC) and molten carbonate fuel cells (MCFC) have high efficiency. SOFC and MCFC can contribute towards decreasing the amount of exhausting CO_2 due to generation of electricity however; miniaturising and portability are very difficult because of their high operating temperatures.

Phosphoric acid fuel cell (PAFC) has lower operating temperatures than SOFC and MCFC and is expected for local area use. However, its liquid electrolyte is not suitable for mobile use. Polymer electrolyte fuel cell (PEFC) with solid polymer electrolyte membrane works around 100 °C. PEFCs are good at quick-start and stop. Therefore PEFCs are expecting as an alternative energy system for mobile use.

PEFCs are widely studied and expected to be produced for practical use. However, there are serious problems for PEFC (using proton exchange membrane) concerning the increasing cost of platinum catalysts and decreasing amount of platinum resources[2].

Alkaline membrane fuel cells (AMFC) have recently been receiving a lot of attention among the different types of fuel cells. The alkaline systems potentially offer advantages in that they do not require much noble metal catalyst as acidic systems; have faster reaction kinetics (enabling higher power densities); can better limit fuel cross-over; and cost less than proton exchange membrane systems using alcohol as fuel.

Many anion exchange membranes based on quaternised polymers have been developed and studied for AMFC[3-5]. The quaternary ammonium functional groups are the anion conductors in the membranes. However, the performance of AMFC based on this type of membrane is still low due to easy degradation in alkaline medium at temperatures above 60 °C. Nevertheless, the development of anion exchange membranes for AMFC is still in the early stage. It is still required to develop the anion exchange membranes for an improved performance of AMFC[6].

The aim of this work is to prepare the anion exchange membrane based on polyvinyl alcohol (PVA) and sulfonated polyetheretherketone (SPEEK), and studies its properties for AMFC application.

EXPERIMENTAL

One of the starting materials, SPEEK was prepared via sulfonating PEEK by concentrated sulforic acid.

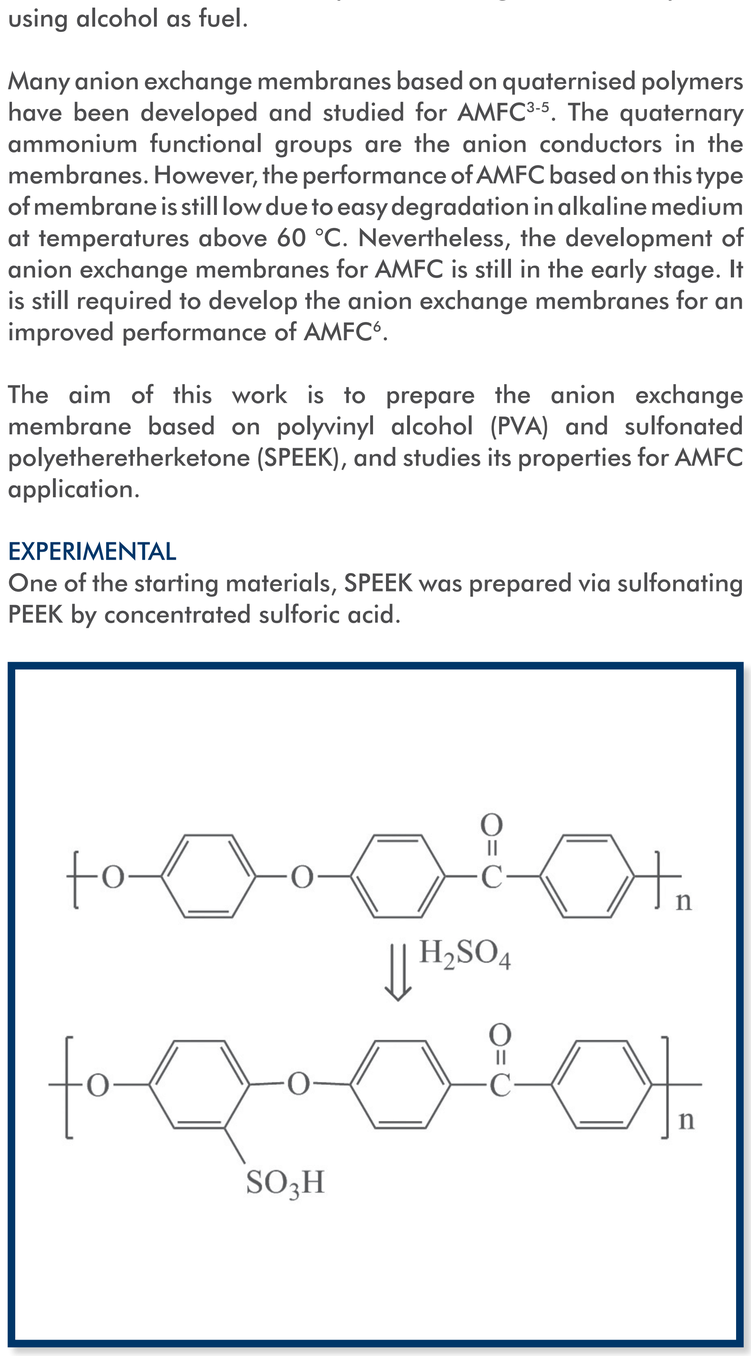

Figure 1: Synthesis of SPEEK

A series of anionic membranes were prepared with various ratios of PVA and SPEEK by solution casting method.

RESULTS

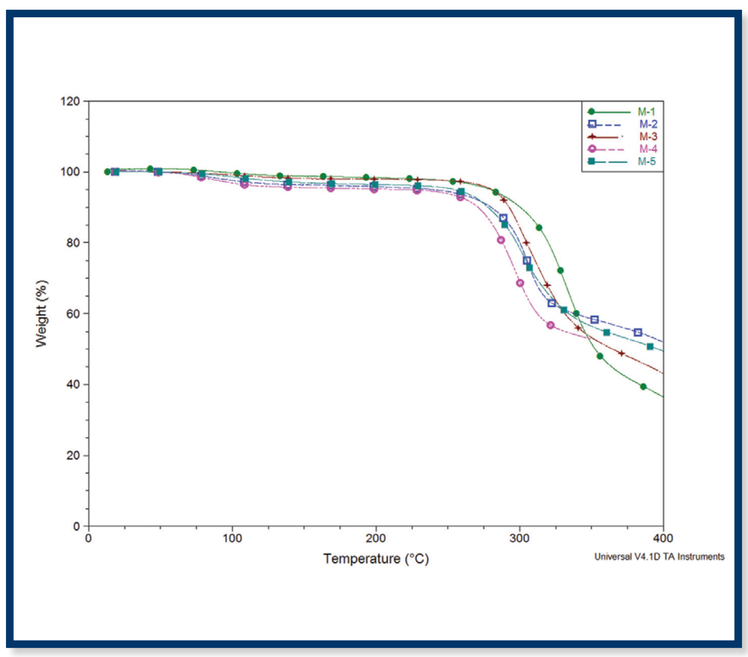

Figure 2: FT-IR of PVA/PEEK membranes

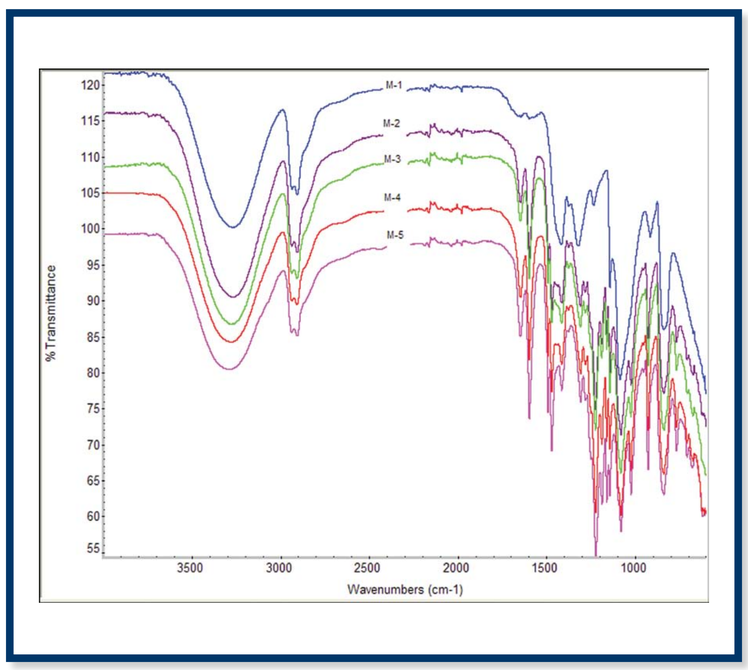

Figure 3: TGA curves of PVA/PEEK membranes

Thermogravimetric analysis (TGA) shows that the degradation of the membranes only starts from 250 °C.

It was found that the ion conductivity of the PVA/SPEEK membranes was increased with increasing amount of PEEK, but the methanol cross-over was slightly increased.

CONCLUSION

A series of PVA/SPEEK anionic membranes were successfully prepared. The PVA/SPEEK membranes have good thermal and higher degradation temperatures. The ion conductivity of the PVA/SPEEK membranes increases with increasing amount of SPEEK, the methanol cross-over also increases.
The fuel cell performances of PVA/SPEEK membranes will be investigated in the future work.

REFERENCES

1. Winter, M. and Brodd, R. J. 2004. What Are Batteries, Fuel Cells, and Supercapacitors? *Chemical Reviews*, 104:4245-4270.
2. Varcoe, J. R., and Slade, R. C. T. 2005. Prospects for Alkaline Anion-Exchange Membranes in Low Temperature Fuel Cells. *Fuel Cells*, 5:187-200.
3. Li, L. and Wang, Y. 2005. Quaternized polyethersulfone Cardo anion exchange membranes for direct methanol alkaline fuel cells. *Journal of Membrane Science*, 262:1-4.
4. Fang, J. and Shen, P. K. 2006. Quaternized poly(phthalazinon ether sulfone ketone) membrane for anion exchange membrane fuel cells. *Journal of Membrane Science*, 285:317-322.
5. Huang, A. Xia, C. Xiao, C. Zhuang, L.. 2006. Composite anion exchange membrane for alkaline direct methanol fuel cell: Structural and electrochemical characterization. *Journal of Applied Polymer Science*, 100:2248-2251.
6. Hou, H., Sun, G., He, R., Sun, B., Jin, W., Liu, H. and Xin, Q. 2008. Alkali doped polybenzimidazole membrane for alkaline direct methanol fuel cell. International *Journal of Hydrogen Energy*, 33:7172-7176.

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