ANM 2018
11th International conference on Advanced Nano Materials
5th International conference on Advanced Graphene Materials
4th International conference on Advanced Magnetic and Spintronics Materials
2nd International conference on Advanced Polymer Materials and Nanocomposites
1st International conference on Advanced Nanoelectronics and Organic light emitting diodes
18-20 July 2018
University of Aveiro, Aveiro - Portugal

ID	Poster Number	Name	Session	Topic	Title
519	APM 22	Carmen M. Rangel	Advanced Polymer Materials	Fuel Cells	Nafion® phosphonic acid composite membranes for proton exchange membranes fuel cells

ANM2018 (www. http://advanced-nanomaterials-conference.com)

18-20 July 2018, Reitoria, University of Aveiro, Portugal

Nafion® phosphonic acid composite membranes for proton exchange membranes fuel cells

Fátima C. Teixeira[1], Ana I. de Sá[1], António P. S. Teixeira[2] and Carmen M. Rangel[1]

[1]Laboratrio Nacional de Energia e Geologia, I.P., Estrada do Paço do Lumiar, 22, 1649-038 Lisboa, Portugal.
[2]Departamento de Química, Escola de Ciências e Tecnologia & Centro de Química de Évora, IIFA, Universidade de Évora,
R. Romão Ramalho, 59, 7000-671 Évora, Portugal
email: carmen.rangel@lneg.pt

INTRODUCTION

The fuel cells are electrochemical devices that convert the chemical energy stored in a fuel, directly and efficiently into electrical energy. Among the fuel cells, the proton exchange membrane fuel cells (PEMFCs) are considered promising power sources, due to their high power density and high power-to-weight ratio and the proton exchange membranes are considered a key material for the operation of these cells. Usually, these membranes are made of organic polymers containing acidic functionalities, but their proton transport properties strongly depend on their water content, which limit their operation temperatures up to 90ºC. These limitations have fostered the interest in research and development of new alternative membranes [1,2].

In order to develop novel membranes for application in PEMFCs, we have synthesized and characterized mono- or 1,4-dissubstituted aryl derivatives with phosphonic (PAs) and bisphosphonic acids (BPs) groups (Fig. 1). The new Nafion® membranes, doped with PAs or BPs, were prepared and characterized. Their proton conductivity was evaluated by electrochemical impedance spectroscopy (EIS) to analyse the influence of the structure of dopants and the method of the preparation of the membranes.

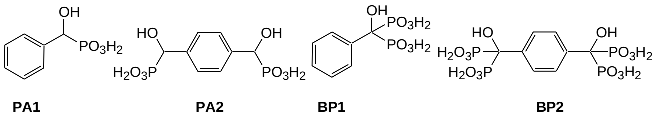

Fig. 1. Structure of prepared PAs and BPs dopants.

EXPERIMENTAL

Dopants with PAs or BPs groups were prepared, using phosphoric acid and phosphorus trichloride or triethylphosphite as reagents, in conditions already established within the group. Membranes were prepared using different approaches, where Nafion® was used as film or solution: by impregnation of commercial Nafion® N-115 films with PA or BP or by casting Nafion®/DMAc solutions using different quantities of dopant.Dopants were characterized by spectroscopic methods (NMR, FTIR) and Nafion® membranes were analyzed by ATR FT-IR spectroscopy. Evaluation of the proton conductivity of the new membranes was performed by EIS, using a frequency response analyzer coupled to a electrochemical interface (from Solartron) and a BekkTech conductivity cell.

RESULTS AND DISCUSSION

The protonic conductivity of all the prepared membranes were determined by EIS at 60°C under different relative humidities (RH) (40, 60 and 80%). For selected membranes, the protonic conductivities were also measured at 30, 40 and 50°C under different RH (Fig. 2).
The proton conductivity of all membranes increased with the increasing of temperature and RH. The membranes prepared by impregnation show lower proton conductivity than Nafion® N-115, but the membranes prepared by casting (Nafion casting/BP1-1.0 and Nafion casting/BP2-2.5) show better conductivity than Nafion® N-115.

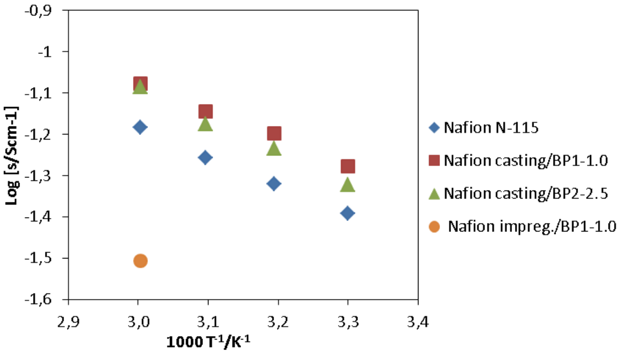

Fig. 2. Proton conductivity of Nafion membranes vs reciprocal temperature at 80% RH

CONCLUSION

New Nafion® membranes doped with phosphonic or bisphosphonic acids were prepared and their proton conductivity were evaluated by EIS. The reported results showed that the bisphosphonic acid dopants increased the proton conductivity of the Nafion® membranes prepared by casting.

REFERENCES

1. H. Zhang et al., Chem Rev, 112, 2780 (2012).
2. C. Laberty-Robert et al., Chem. Soc. Rev. 40, 961 (2011).

ACKNOWLEDGMENTS

This research was supported by the Project “PEMFC-SUDOE” - SOE1/P1/E0293 which is co-financed by the European Regional Development Fund in the framework of the INTERREG SUDOE programme.