ALKALINE ION EXCHANGING MEMBRANES IN POWER SOURCES

P. Barath[1], L. Janík[2], M. Sedlaříková[1], J.Vondrák[2], V. Novák[1], J. Reiter[2]

[1] Institute of Electrotechnology, Technical University of Brno, 602 00 Brno
[2] Institute of Inorganic Chemistry AS CR, 250 68 Řež near Prague

Introduction

The possible application of anion exchanging membranes in chemical power sources is an interesting challenge. For example, its alkaline reaction means much lower requirements on the corrosion resistance of all materials used in power sources. We have measured the impedance and resistivity towards carbonate ions of several samples of membranes.

Experimental

Several materials were tested as a membrane in the fuel cell:

a) NAFION® No. 117
b) Anion exchanging heterogenous membrane RALEX AM (MEGA Inc., Czech Republic)
c) Bipolar membrane FuMA-Tech Ion Exchange Membrane (FT-BP)
d) Anion exchanging membrane manufactured according to J.F. Fauvarque et al [1]. This material was synthesized by addition of DABCO (diazobicyclooctane) on polyepichlorhydrine and trimethylamine. A PE screen was soaked by the liquid form of the ion exchanger and dried; this procedure was repeated several times.

Procedures and accessories

A simple glass vessel with two compartments was designed. The tested membrane was clamped between two parts of the vessel, on which polished flanges were formed. Usually, 2M KOH solution was used. In order to estimate the influence of carbonate ions, the hydroxide was in the course of experiment replaced by 1 M solution of K_2CO_3. + 1M KOH. The behavior at d.c. polarization using a potentiostat ATLAS – SOLLICH (Poland) served as the source of polarization and for impedance measurements. The morphology of membrane surfaces was observed by an environmental SEM.

Results and Discussion

NAFION®

The voltage drop across NAFION membrane is not higher than 100 – 200 mV. The

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Corresponding author: Jiří Vondrák
E-mail: (vondrakj@iic.cas.cz)
Phone: +420 266 172 198, Fax: +420 220 941 502

impedance can be expressed as (1 + j . 6) Ω in low – frequency range. Hence, the membrane´s behaviour can be described as capacitive.

RALEX AM

The properties of this membrane are rather simple. The voltage drop in KOH solution was below 80 mV, after insertion of K_2CO_3 increased rapidly to 160 mV. However, if the electrolyte was replaced back to pure KOH, the voltage drop was fairly below 50 - 60 mV. The impedance has a marked out-of-phase component (10 + j, 63 Ω). The morphology of its surface is shown in Fig. 1 (magnification 750x).

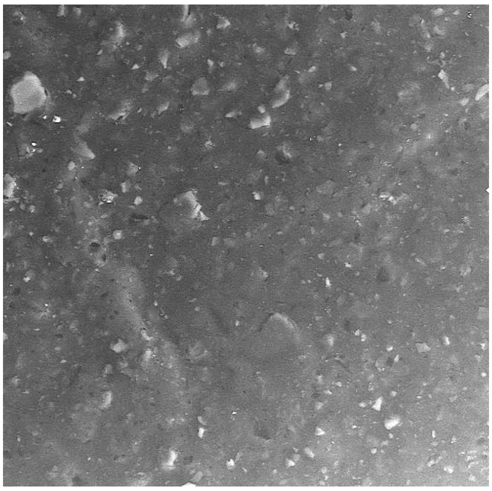

***Fig. 1** The inhomogeneity of the membrane caused by its swelling is clear from this picture, on contrary to Nafion, which was apparently quite homofenous.*

FuMA-Tech Ion Exchange Membrane (FT-BP)

According to expectation, the voltage drop across this membrane was as high as 4 to 5 volts. Also the impedance was rather high and quite surprising in shape, as is indicated in Fig. 2. It is not easy to explain it and it will be worth of an extended investigation.

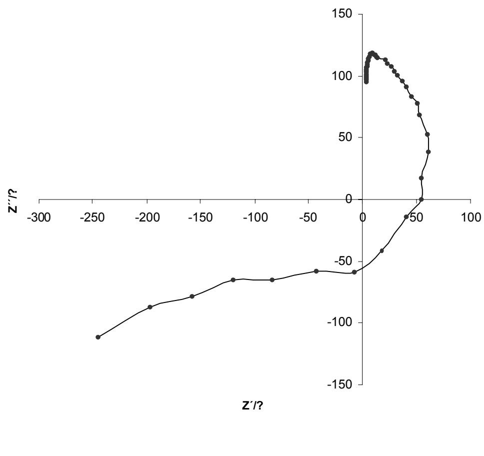

***Fig. 2** The impedance spectrum of the FT-BP membrane.*

DABCO based membrane

The voltage drop of this membrane decreased in the solution from rather high values down to 0.27 V in KOH. After replacing the electrolyte by the mixture of KOH and carbonate, it rised again and the steady – state value was close to 0.5 V. It is more than the voltage drop of the RALEX AM membrane. However, these results are the very first ones and they offer the possibility of further improvement.

The surface of this membrane was far from being smooth (see Fig. 3). This is caused perhaps by the procedure of polymer deposition onto the reinforcement screen.

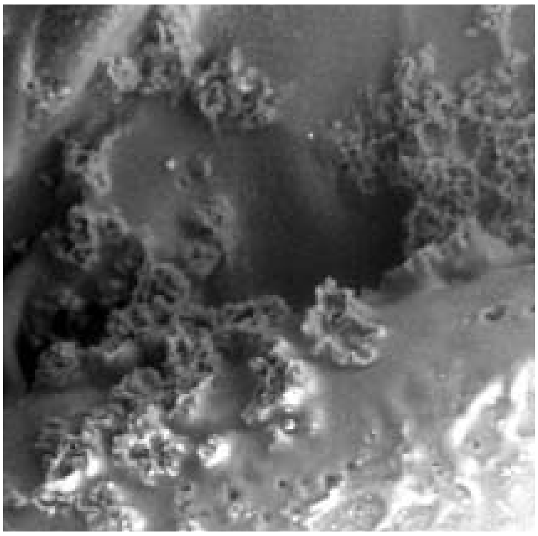

Fig. 3 *SEM picture of FT-BT (magnification 750x, 280 µm).*

Acknowledgements

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References

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