PREPARATION AND CHARACTERIZATION OF UV-CURABLE ORGANIC-INORGANIC MEMBRANES FOR FUEL CELLS

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Nowadays researchers are challenged to solve the environmental issues related with atmospheric pollution, green house effects and global warming, therefore they develop new types of efficient environmentally-benign energy devices. Direct alcohol fuel cells (DAFC) which use methanol or ethanol as a fuel are considered as promising energy conversion devices due to their high energy efficiency, low emission, simple operating conditions at a relatively low temperature, no requirement of fuel reforming process and environmentally friendly nature. To improve the performance of DAFC, especially to reduce methanol crossover, considerable efforts have been made to modify commercial solid polyelectrolyte membrane Nafion. Recently organic-inorganic composites have got a great attention as the alternative nonfluorinated PEM materials. They are known to improve mechanical and thermal properties as well as proton conductivity.

The series of membranes were prepared by UV-initiated polymerization of acrylic monomers (acrylonitrile AN, acrylic acid AA and potassium 3-sulfopropylacrylate SPAK) at the presence of photoinitiator (2,2-dimethoxy-2-phenylacetophenone (DMPA)) and cross-linker (ethyleneglycole acrylate EGDA), and simultaneous sol-gel process of MAPTMS (methacryloxypropyltrimethoxysilane)-based sol-gel system. Characterization of the obtained nanocomposites includes measurements of proton conductivity, ion-exchange capacity, thermal and chemical stability, methanol uptake.

The values of proton conductivity of the obtained membranes are relatively high (reaching $1{,}12 \cdot 10^{-2}$ Sm/cm at 60 ºC Sm/cm, what is comparable to Nafion) and depend on temperature and the content of sol-gel system added (Fig. 1).

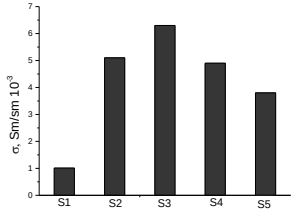

Fig. 1. Proton conductivity as a function of MAPTMS content

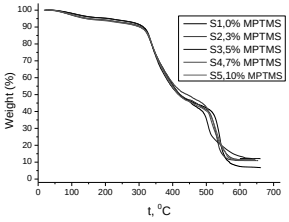

Fig. 2. TGA curves of PEM samples

Organic-inorganic membranes demonstrate high thermal stability (Fig. 2) and ion-exchange capacity (1.12 – 1.68 meq/g). Membranes also show relatively high oxidative stability in Fenton reagent at 60 °C after 36 h testing. Methanol uptake of membranes is smaller than that of Nafion. Hence, self-crosslinked silica network formed as a result of sol-gel process suppresses the swelling and methanol diffusion and also improves the stability, water retention and mechanical strength of PEM. The synthesized PEMs are good candidates for fuel cell application.