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New SPEEK/poly(arylene ether) blend-nanocomposite membranes via sol-gel method

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Proton exchange membranes composed of perfluorosulfonic acid polymers suffer from some drawbacks, such as high cost, low application temperature (<80 ℃) and high methanol crossover [1]. To substitute the Nafion type perfluorinated ionomer membranes, the search for alternative proton-conducting polymer membranes has been intensified to a great extent in the last decade. Among the most promising candidates for substitution of Nafion are different types of commercial polymers with arylene backbone such as different types of poly(etherketone)s, poly(ethersulfone)s, and polyphenyleneoxide (PPO). It was, however, shown that commercial polymers cannot fulfill all the requirements of fuel cell membranes, such as chemical stability and advantageous proton conductivity/water uptake relation (high proton conductivity at as low as possible water uptake). Therefore, the efforts of the scientific community to improve the properties of alternative fuel cell membranes were mainly strengthened in three directions:

- Crosslinking of the sulfonated polymers,
- Preparation of organic–inorganic composite membranes from commercial polymers,
- Development of new (block-co)polymers with arylene backbone such as nonfluorinated and partially fluorinated polyarylene ethers (PAE), or polymers containing phenylphosphine oxide unit [2].

In recent years, organic–inorganic hybrid materials have been extensively investigated due to the fact that they combine both the advantages of organic polymers such as the ease of processing, good impact resistance, flexibility, etc. and the advantages of inorganic materials such as high mechanical strength, transparency, good chemical resistance and thermal stability, etc [3].

In this study, mainly second direction was followed. First, blend membranes were prepared mixing PAEs composed of decafluorobiphenyl and 6F-Bis A with molecular weights of 30.000 g/mol and SPEEK with a sulfonation degree greater than 60%, to have comparable proton conductivity to that of Nafion® membrane. The membranes were prepared by solution casting method in 20 w/v% concentrations in N,N-dimethylacetamide (DMAc). The effects of the ratio of poly (arylene ether) (SPAE) to SPEEK on the membrane properties were investigated. [4] Than, new blend-nanocomposite PEMs were obtained by incorporating the sol–gel precursor in the range of 0 to 15 wt% into the organic blend system. These membranes were than characterized by proton conductivitiy, chemical degradation, IEC (ion exchange capacity) measurements and also FTIR (Fourier Transfer Infrared), 1H NMR (Nucleer Magnetic Resonance) and SEM (Scanning Electron Microscopy).

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