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NOVEL HIGH PERFORMANCE HETEROGENEOUS NANOCOMPOSITE PROTON EXCHANGE MEMBRANE BASED ON POLY(ETHER SULFONE) WITH MAGNETIC FIELD-ALIGNED γ-FE2O3 NANOPARTICLES

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Fuel cells are considered as efficient energy-conversion devices to reduce demands for fossil fuels and nuclear-derived energies. Proton exchange membrane(PEM) is considered as a key component in fuel cells. The current state-of-the-art PEM is nafion. This unique polymer fulfils high proton conductivity, excellent chemical durability and mechanical strength. Notwithstanding these desirable properties, high manufacturing costs, loss of conductivity at elevated temperature and high fuel permeability have limited its large-scale applications. Recently, Sulfonated poly(ether sulfon) has become the subject of considerable interest due to its unique characteristics of high thermal, chemical and oxidative stability, good mechanical properties and low cost as well as easier processing. However, excessive swelling and loss of conductivity owing to degradation of sulfonic groups at elevated temperature have restricted its applications. Incorporation of inorganic fillers in to polymer membranes can improve their properties. Recently, much effort has gone in to development of transport properties of PEMs in the thickness direction which is most relevant for meeting special engineering targets.

The goal of the present study is on developing anisotropic PEM with high proton conductivity through film thickness. In this regard, nanocomposite membranes with different amount of γ-Fe2O3 nanoparticles were fabricated by the application of magnetic field during solvent casting. By clustering sulfonic acid groups of PES around aligned nanoparticles, oriented channels for proton transportation in the thickness direction could be achieved. Moreover, aligned structure would lead to the reduction of free-volume where methanol molecules transport. Therefore the resistance to the diffusion of methanol molecules would be increased. To evaluate the potential performance of membranes for fuel cell, the selectivity parameter (ratio of proton conductivity to methanol permeability) was calculated. Results confirmed considerable improvement of selectivity in membrane with aligned morphology as compared to randomly distributed nanocomposite. Our results revealed that nanocomposite membranes with ordered structure could be considered as potential polyelectrolytes for fuel cell applications.