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Proton conductivity and characterization of novel composite membranes for medium-temperature fuel cells

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Abstract

Direct methanol fuel cells (DMFC) have received considerable attention both as a portable power source and as a replacement for batteries. The available conventional Nafion membranes currently used in hydrogen fuel cells are not suitable for use in DMFC due to their dehydration and instability at temperatures higher than 100EC. Novel composite membranes have been prepared with the help of a sulfonated polyether ether ketone (SPEEK) polymer and a novel solid proton conductor, namely heteropolyacid-loaded Y-zeolite. The novel solid proton conductor has high proton conductivity and high thermal and structural stability because of the presence of Y-zeolite. The conductivity of the composite membranes at room temperature as well as at higher temperatures was found to increase with the incorporation of solid conducting material particles into the SPEEK polymer. The conductivity increased by 3–4 times at room temperature and increased to exceptionally high values at temperatures higher than 100EC. In all cases the presence of the solid proton conductor led to an increase in conductivity of the membranes without detriment to their flexibility. Water uptake of the membranes also followed a similar trend as that of conductivity. The membranes were characterized by XRD, FTIR and SEM techniques, which confirmed even distribution of solid material into the SPEEK polymer. Hence, these low-cost membranes can be considered for use in DMFC for portable devices as well as for medium-temperature stationary applications.

Keywords: Composite membranes; Proton conductivity; Solid proton conductors; Heteropolyacids; Y-zeolite