Polyethylene based anionic exchange membranes for solid alkaline fuel cells (SAFC)

Ali Sherazi, Syed Tauqir; Sohn, Joon-Yong; Li, Shenghai; Guiver, Michael D.; Lee, Young Moo

16 – Oral presentation

Polyethylene based anionic exchange membranes for solid alkaline fuel cells (SAFC)

Syed Tauqir Ali Sherazi[a], Joon-Yong Sohn[g], Shenghai Li[h], Michael D. Guiver[i], Young Moo Lee[j],

[a]COMSATS Institute of Information Technology (sherazi_212@yahoo.com), [g]Advanced Radiation Technology Institute, Korea Atomic Energy Research Institute, Jeongeup-si, Jeollabuk-do 580-185, Korea, [h]WCU Department of Energy Engineering, College of Engineering, Hanyang University, Seoul,133-791, Korea, [i]Institute for Chemical Process & Environmental Technology, National Research Council, Ottawa, Ontario, K1A 0R6, Canada, [j]WCU Department of Energy Engineering, College of Engineering, Hanyang University, Seoul,133-791, Korea,

Among various types of fuel cells, the SAFC is the most recent one and has advantages such as better kinetics of the oxygen reduction reactions and application of less expensive non-noble catalysts such as silver and nickels contrary to expensive one (Platinum) required for proton exchange membrane fuel cell (PEMFC). AEM is a crucial part in solid alkaline fuel cell (SAFC), determining the durability and electrochemical performances of membrane electrode assembly (MEA). The role of an AEM is to conduct hydroxyl ions from cathode to anode. If this conduction is not sufficiently high and selective, the corresponding fuel cell will not find any practical application. One of the major problems associated with SAFC is much lower conductivities of anion compare to proton conductivity in PEMFCs, even upon similar working condition [1]. Thus AEMs is only practical, if it is chemically and mechanically stable against severe basic operation conditions and highly hydroxyl ions conductive. The conventional AEMs based on aminated aliphatic and aromatic hydrocarbon or even fluorinated polymers tend to be attacked by hydroxyl ion, causing the degradation during operation in strongly basic conditions [2]. In the present study, Vinyl benzyl chloride was grafted onto ultrahigh molecular weight polyethylene (UHMWPE) powder by γ-radiation grafting technique. The grafted powder was then converted into film by melt pressing. The main advantages of using UHMWPE are: its inexpensive nature, excellent bulk physical/chemical properties, crosslinking tendency upon exposure to γ-rays and above all it is quite stable to the alkaline medium. The grafted membranes were then reacted with various cationic functional groups, quaternary ammonium groups and modified guanidine groups in order to investigate the stability and hydroxyl ion conductivity. The performances of the AAEMs, including ion exchange capacity (IEC), water and methanol uptake (WU), In-plane swelling, methanol permeability, and ionic conductivity were investigated systematically. The thermal stability of the membranes was also determined. An interested feature has been observed that the ionic conductivity of PE-g-VBC-TMAOH membranes, with only 12.6% degree of grafting, approaches 0.05 S cm^{-1} at 90 ºC while the corresponding methanol permeability is in the order of 10-8 at 30ºC. The results indicate that the developed membranes can be possibly used as alkaline anion exchange membrane for fuel cells.

Reference:

1. F. Barbir, PEM Fuel Cells Theory and Practice, MA, 2005.
2. G. Couture, A. Alaaeddine, F. Boschet, B. Ameduri, Prog. Polym. Sci., 36, 1521-1557 (2011).