Effect of Phosphoric Acid for Ion Conduction of Calcium Phosphate Glass Gel as An Electrolyte Membrane in A Middle Range Temperature Operated Fuel Cell.

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Introduction

Polymer electrolyte membrane fuel cells (PEMFC) are attracting considerable interest as alternative power sources for automobiles, stationary and portable applications. The PEMFC is considered to be one of promising compared to other non-conventional power sources because of high-power density.

Direct PEMFC using cyclohexane and decalin has been studied in our laboratory. This System is expected to work efficiently at high temperature. However, the present proton exchange membranes in PEMFC are fabricated with organic components, so they decompose at high temperature. To solve these problems, we have employed calcium phosphate glass gel as a new polymer exchange membrane and studied the basic additive effects for improvement of conduction of calcium phosphate glass gel.

Experiment

We prepared calcium phosphate glass gel according to the literature method[1]. Figure 1 is a typical photo of the prepared gel.

To investigate the additive effect on conductivity of calcium phosphate glass gel, phosphoric acid, HMM-1 (a mesoporous silica material), Nafion®, and PTFE were added to the gel, and the mixed samples were left for 24 h. The conductivities of all samples were measured by alternating current impedance method. Effect of the concentration of H_3PO_4 was also investigated (Figure 3).

Results and Discussion

Figure 4 shows conductivities of the glass gels containing phosphoric acid or other additives. The best value of conductivity of was obtained for the H_3PO_4 containing gel. The optimum concentration of addition of H_3PO_4 was 20 wt.%, and its conductivity was 2.6×10^{-2} S/cm at room temperature (298K). Concerning the structure of calcium phosphate gel does not change by addition of phosphoric acid (confirmed by XRD measurement), it can be concluded that the enhancement of ion conductivity is due to the increase of the concentration of H^+ in the gel. The ion conductivity of the glass gel containing 20 wt.% of H_3PO_4 was increased as increase of temperature, and the best value was obtained at 353K, 6.0×10^{-2} S/cm (Figure 2).

References

1)T.Kasuga,T.Wakita,M.Nogami,M.Sakurai,M.Watanabe, andY.Abe,*Chem.Lett,***820**(2001)
2)T.Kasuga,M.Nakano,andM.Nogami,*Adv.Mater*.,14,**1490**(2002).

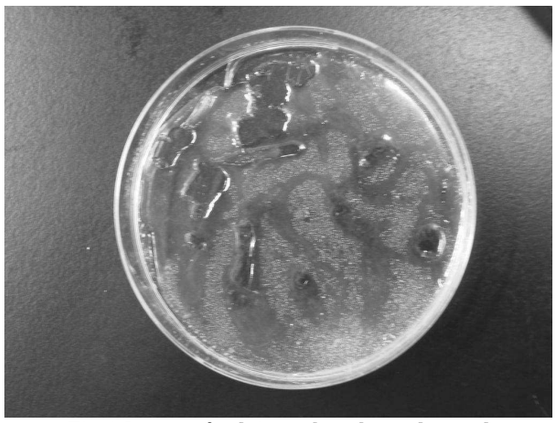

Fig.1 Image of calcium phosphate glass gel

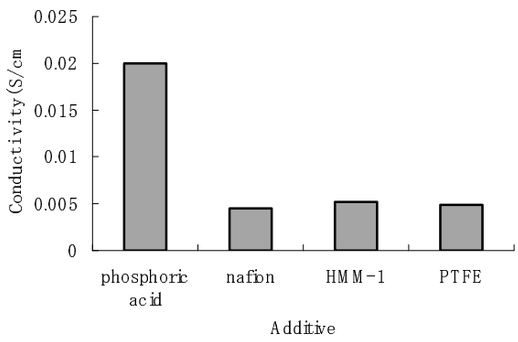

Fig.2 Effect of the additives for the conductivity of the glass gel.

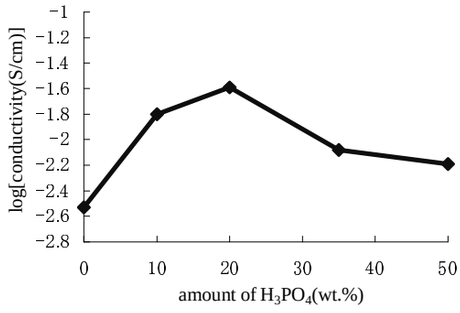

Fig.3 Conductivity effect of H_3PO_4 concentration on ion conductivity of the glass gel

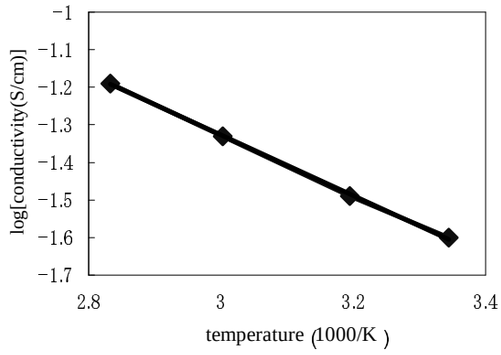

Fig.4 Effect of the additives for the ion conductivity of the glass gel