Heteropoly acid Immobilization and Crosslinking in a Polymer Electrolyte Membrane for Fuel Cells

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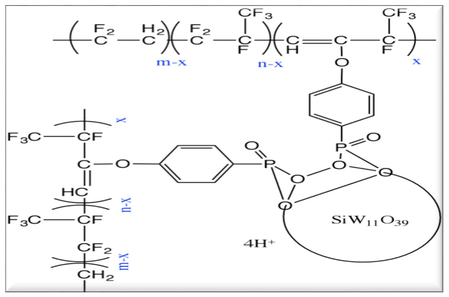
Introduction

Heteropoly acid (HPA) was attached, cross-linking, a novel fuel cell polymer membrane



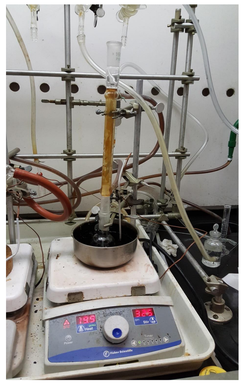
- HPA is a good proton conductor at hotter and drier conditions
- Covalent bonding to the polymer prevents the HPA from washing out in water
- Cross-linking reduces swelling

Objective of Research

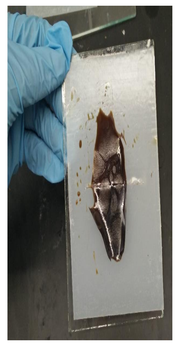
Determine how membrane annealing time and temperature in the K+ and H+ form affect the attachment of HPA to the polymer backbone in order to maximize the HPA attachment

Research Method

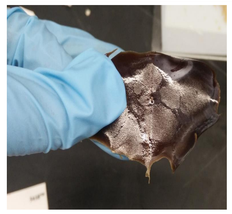
HPA (70wt%) added to polymer solution with the H+ catalyst



Cast polymer solution to form membrane



Characterization Technique



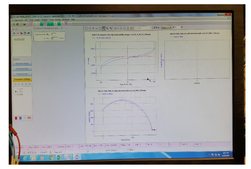
Anneal at different temperature and time in K+ and H+ form to further attach HPA

Soak membrane in 1M H_2SO_4 solution to ion-exchange from K+ to H+ form

Soak in H_2O for 16 hours

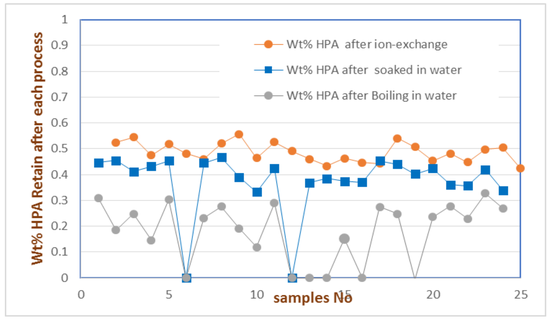
Boil in H_2O for 1 hour

Measure membrane and perform EDX to determine the %HPA immobilized.



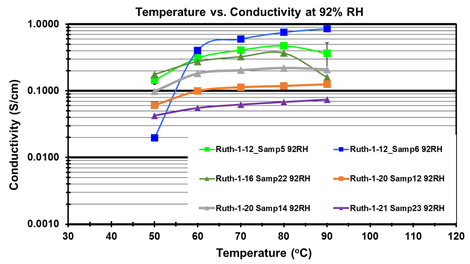
PEIS was used to measure proton conductivity under various temperatures and humidity

Screening Process



After Ion Exchange – about 50% HPA left
Soaked in water – about 40% Retained
Boiled in water – about 20-30% left

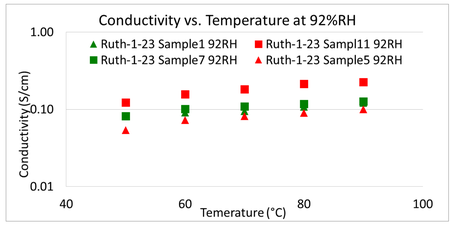
Proton Conductivity Data



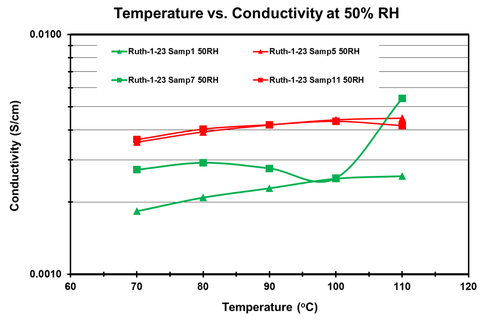
Concentrated solutions (**Sample 5 and 6**), were annealed at high temperature for 24hrs in the K^+ form but not in the H^+ form.

Dilute solution **(sample 22),** was annealed at a low temperature for 24hrs in the K^+ form and also in the H^+ form.

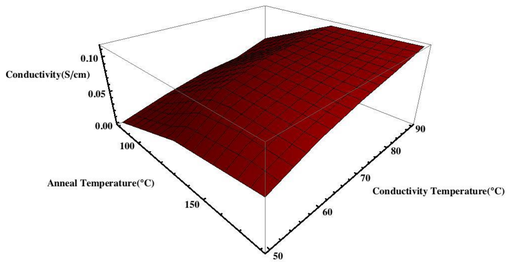
Conductivity (S/cm) at 92RH is consistently high independent of processing conditions. This conductivity approaches or surpasses the highest reported conductivities in polymer materials.

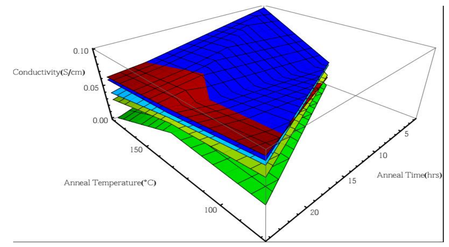


Sample 7 and 11 annealed in K+ and H+ form
Sample 1 and 5 annealed in K+ form only

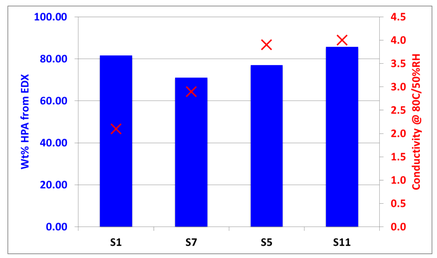


Conductivity increases with both increasing annealing temperature and temperature at which the conductivity is measured.





Conclusion



- SEM/EDX result - Membrane annealed for a longer time and higher temperature in both K+ and H+ form gives better conductivity in PEM fuel cell application.
- At higher temperature the molecules are moving faster for a better proton conductivity.

Future Work

- Anneal films at 80°C for 2hours
- Try different annealing time between the range of 12-16 hours in order to improve the performance of the membrane.
- The use of methanol instead of Dmac and crosslinking for flexibility especially the concentrated solution.

Acknowledgements

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