Electronic Supplementary Information

"Novel Fuel Cell Membrane with High Efficiency"

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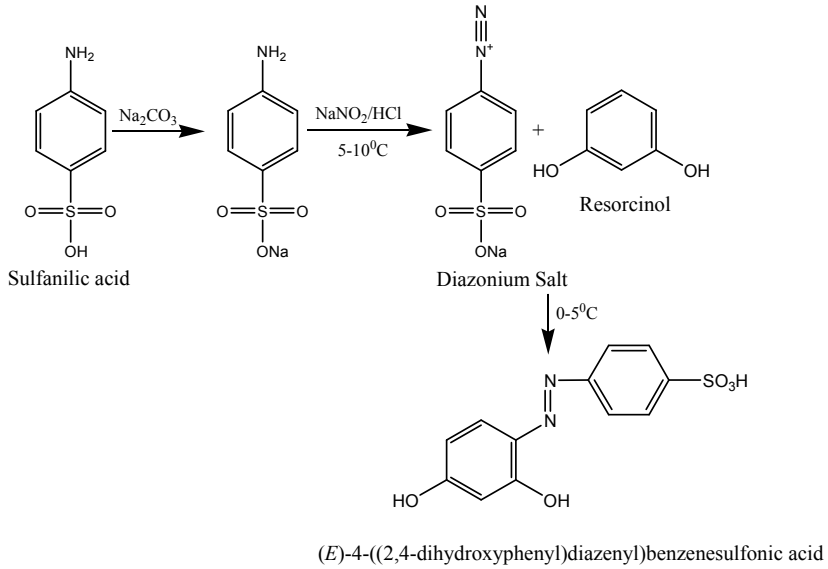
The scheme for the synthesis of azo based ionic diol, (E)-4-((2,4-dihydroxyphenyl) diazenyl)benzene sulfonic acid is shown in scheme S1.



(*E*)-4-((2,4-dihydroxyphenyl)diazenyl)benzenesulfonic acid

Scheme S1 Synthesis of azo based ionic diol.

HPLC analysis was performed for azo based anionomers at two different wavelengths such as 270 and 350 nm. The expand region of the azo based diol at a wavelength of 270 nm is shown in Fig. S1 and confirms the absence of starting material.

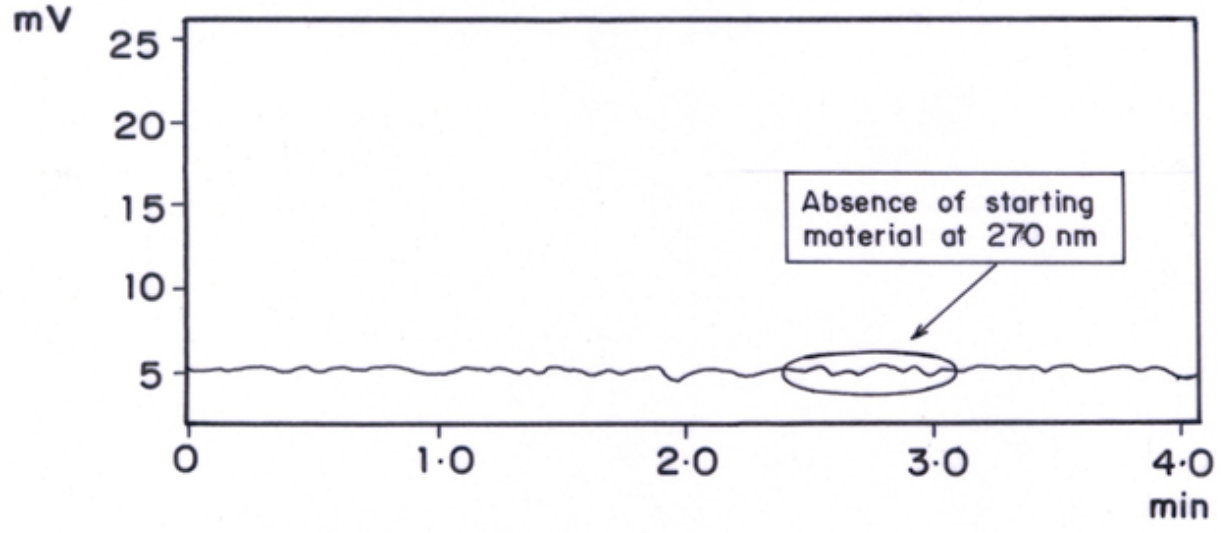


Fig. S1 HPLC chromatogram of the expand region of azo based ionic diol at a wavelength of 270 nm.

The FT-IR spectrum of the azo based monomer is depicted in Fig. S2. The strong characteristic peaks at 1033 cm^{-1} and 1120 cm^{-1} were assigned to symmetric and asymmetric stretching of the sulfonate groups.

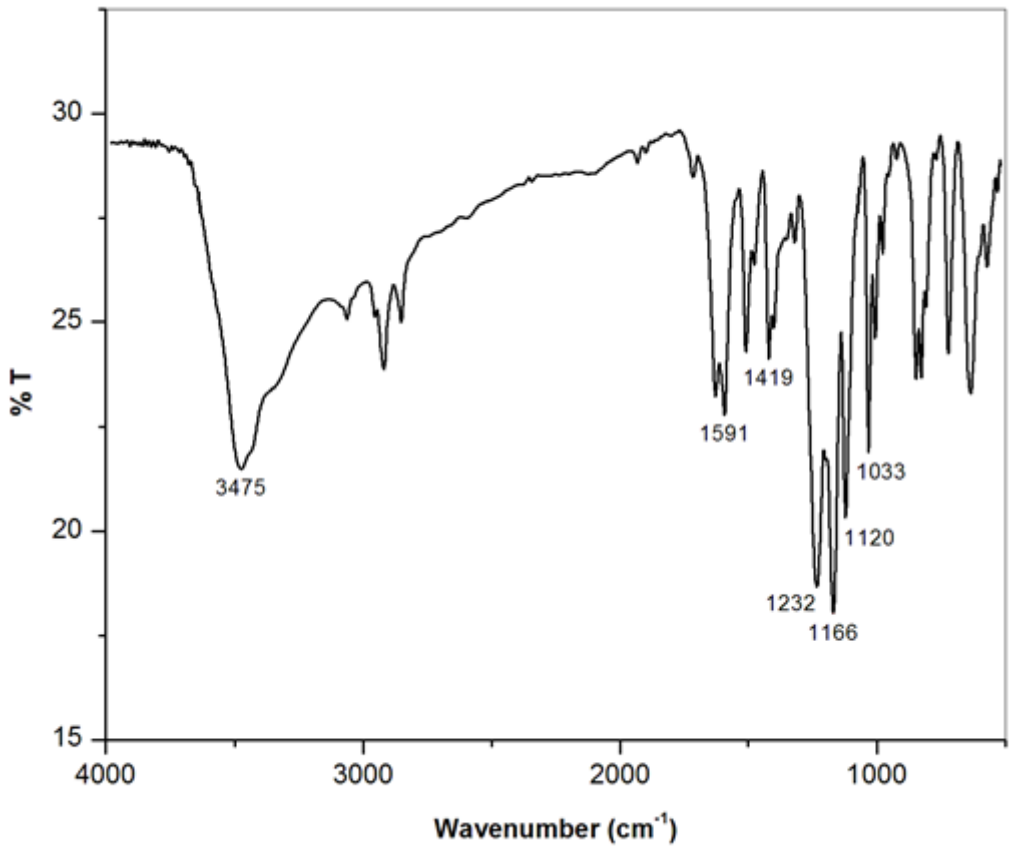


Fig. S2 FTIR spectrum of azo based diol.

Activation energy (E_a)[1] was calculated from the proton conductivity values by using the following equation 1.

$$\ln \sigma = - \frac{E_a}{RT} \qquad \ldots\ldots (1)$$

Where,

- σ - Proton conductivity in S/cm.
- E_a - Activation energy of proton conduction in KJ/mol.
- R - Universal gas constant (8.314 J/mol).
- T - Absolute temperature in Kelvin.

The higher water uptake capacity of a polymer generates more solvated species, which is necessary for proton conduction. The water uptake capacity of all SPAES membranes increasing linearly and the similar trend was also observed in ion-exchange capacity. The influence of ion-exchange capacity on the water uptake of SPAES membranes is depicted in Fig. S3.

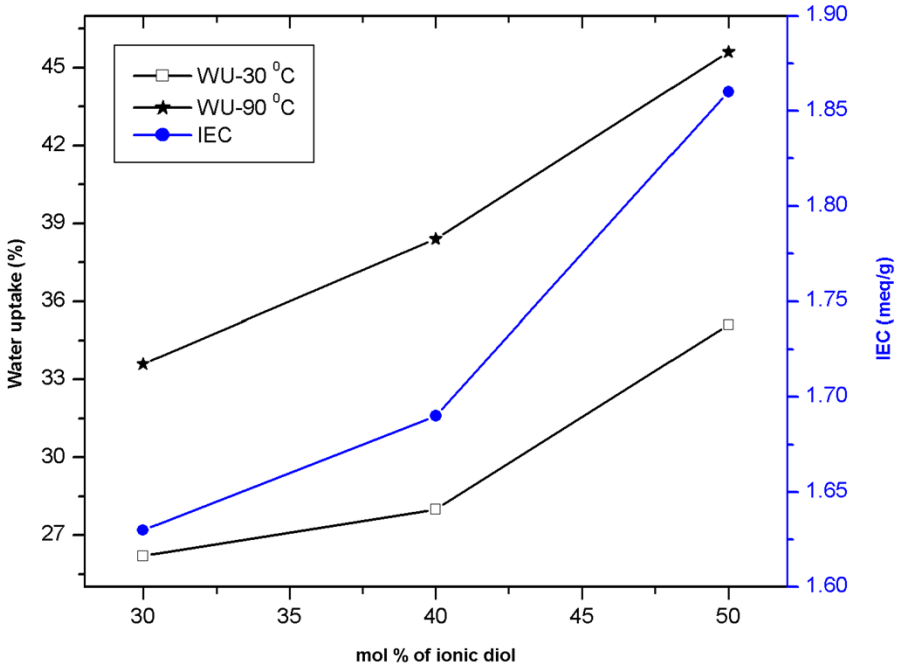


Fig. S3 Water uptake and ion-exchange capacity of the SPAES membranes.

Gel permeation chromatography

Gel permeation chromatography (GPC) was performed on a VISKOTEK TDA 305-040 Triple Detector array refractive index (RI), viscometer (VISC), low angle light scattering (LALS), right angle light scattering (RALS) GPC/SEC module. Separations were achieved by three columns (T6000M, GENERAL MIXED ORG 300x7.8 MM) and one guard column (TGUARD, ORG GUARD COL 10x4.6 MM), 0.025 M LiBr in DMF as the eluent at 60 °C. GPC samples were prepared at concentrations of 5 mg/mL. A constant flow rate of 1 mL/min was maintained. System was calibrated by PMMA standards.

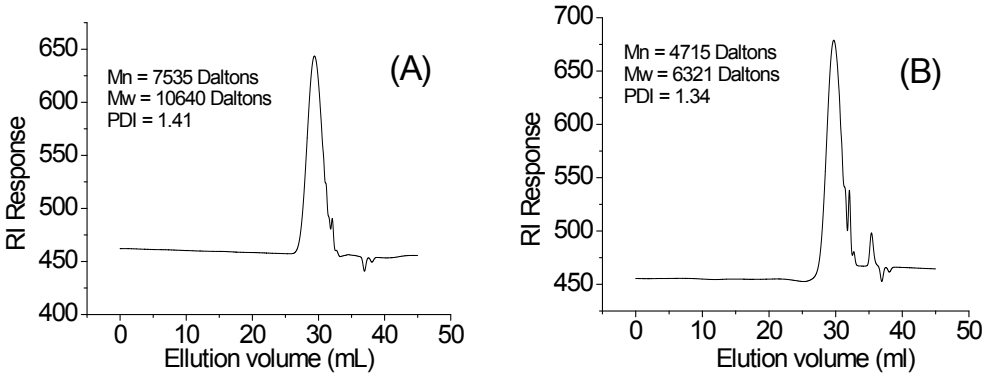


Fig. S4 GPC traces of (A) SPAES-30 and (B) SPAES -40

Reference:

1. X. Zhou, E. Weston, E. Chalkova, M. A. Hofmann, C. M. Ambler, H. R. Allcock and S. N. Lvov, *Electrochim. Acta.*, 2003, **48**, 2173.