

washing and drying, the membrane was analyzed using UV-VIS spectrophotometer, to determine qualitatively the amount of inorganic phase distribution in the organic polymer matrix. The transparency of the composite membrane is a measure of inorganic phase distribution in the range of nanoscale dimension in the organic polymer matrix [Khana, P.K. et al. 2005]. If phase dissociation has taken place, the composite membrane formed is neither transparent nor translucent. Phase separation and homogeneity of the particle distribution also influence the mechanical strength properties of the membrane. Physical visibility of Nafion 112 (commercial) and all the composite membranes are transparent in the UV-VIS spectrum at the annealing time of 10 hours and temperature of 140°C, which indicated the absence of the phase separation of both the inorganic and organic phase (The UV-VIS) result is shown in [Mahreni, A et al. 2008].

The result also showed that there are chemical interactions taking place between the organic and inorganic compounds through the hydrogen bonding between the sulfonate group of Nafion polymer and the hydroxyl (OH) group of the silanol Si(OH) produced via the hydrolysis of TEOS molecules. On the other hand, the electrostatic interactions between the ions of $H_3PW_{12}O_{40}$ and SiOH took place in the composite membrane material. Therefore, the composite membrane has strong bonding between organic-inorganic compounds, which could have been responsible for the transparency and homogeneous distribution of the inorganic phase in the organic matrix.

SEM and TEM analysis

The morphology of the composite Nafion-SiO₂ recasted membrane are shown in Fig 2. It can be seen that the solid SiO₂ and PWA are uniformly distributed within the membrane and do not form any agglomerate structures. The thickness of composite membrane is measured to be $70 \pm 5 \mu m$.

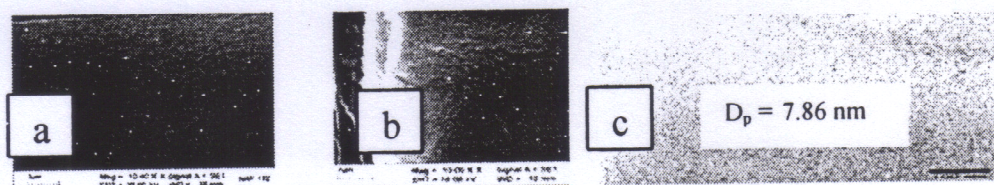


Figure 2.

(a) SEM Cross Section Image of Nafion 112 (Commercial)
 (b) NS15W With Magnification 10.000 X, (c) TEM Cross Section Image of NS15W Membrane With Magnification 60.000 X, (NS10W and NS20W are not shown)

FTIR analysis

The interactions between SO₃H and SiOH and PWA were studied by FTIR which were used to monitor the formation of Nafion/SiO₂/PWA nanocomposite film [Ramani, V. et al. 2005]. The FTIR spectra at 4000-400 cm⁻¹ were shown in Fig.