

Characteristics of Pt-Nafion Composite Prepared by Sputtering-Chemical Reduction

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In Nafion-electrocatalyst system, one of the most important factors was how to deposit electrocatalyst onto the membrane. Nafion has a low surface energy, so the adhesion of electrocatalyst to the Nafion is so weak. Poorly adhesion between the membrane and the electrocatalysts affects on increasing contact resistance between membrane and electrocatalyst. Much attention must be given to the structure and adhesion of the electrode onto the Nafion because they have to support high mechanical tensions during gas evolution. To improve mechanical contact between membrane and electrode, surface roughening of the membrane was achieved with abrasive paper on an electrical grinding machine. Alternatively wet-abrasive blasting, ion beam, sandblasting and plasma etching were tested [1,2]. In addition to, surface roughening of the membrane was effective in improvement of adhesion and decreasing contact resistance between membrane and electrocatalyst [3]. For the purpose of diminishing the contact resistance, in our study we investigated the electrochemical property of Pt-Nafion composite was characterized by cyclic voltammetry and a.c. impedance analysis. H_2PtCl_6 and $NaBH_4$ were used as an electrode material and reducing agent, respectively. For additional improvement of adhesion property between the membrane and electrocatalyst, Pt sputtering was performed prior to platinum deposition by chemical method. To control the thickness and sputtering rate of Pt, we used thickness monitor (Maxtor, TM103R). The speed of sputtering was 6 Å/min. The thickness of sputtered Pt were varied from 10 to 20 nm, ion beam energy was 1keV and amount of blowing oxygen gas was 8 sccm(ml/min.).

Fig. 1 shows the AFM images on Nafion and sputtered Pt on it. As grows Pt sputtering, there was more cracks and homogeneous film formation. It was due to the difference of elongation between Nafion and Pt when sputtering. The XRD patterns of different samples in Pt/Nafion composites were given Fig. 2. The diffraction peak at $2\theta \approx 40$ shows Pt (111). The peak is more increasing with the progress of sputtering and chemical reduction of Pt than Nafion. All samples show preferential crystallographic orientation-face centered cubic (fcc) structures of Pt. The cyclic voltammograms of Pt/Nafion composite in 0.5 M H_2SO_4 are shown in Fig. 3. The hydrogen adsorption/desorption peaks can be seen in the potential range -0.3, +0.1V. One can see that more Pt sputtering leads to an increase in both the anodic and cathodic portions of the potention-dynamic curve than less sputtering. It is suggested that the peaks indicate possible structural changes in the surface layer. The increasing of area in hydrogen adsorption represented as the charge increasing, which takes part in charge transfer a unit area during a time

References

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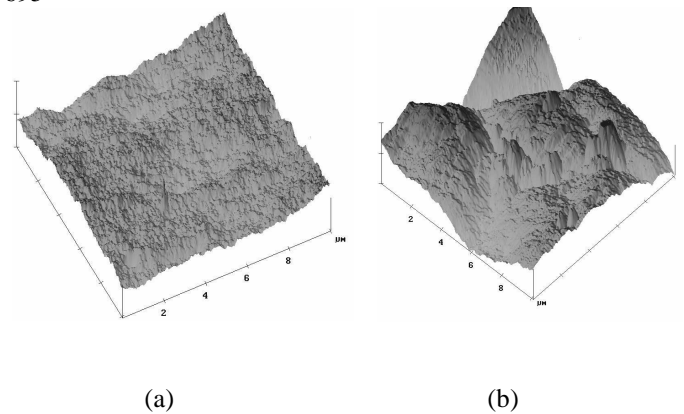


Fig. 1 AFM surface images of (a) Nafion (b) 100nm Pt sputtered Nafion

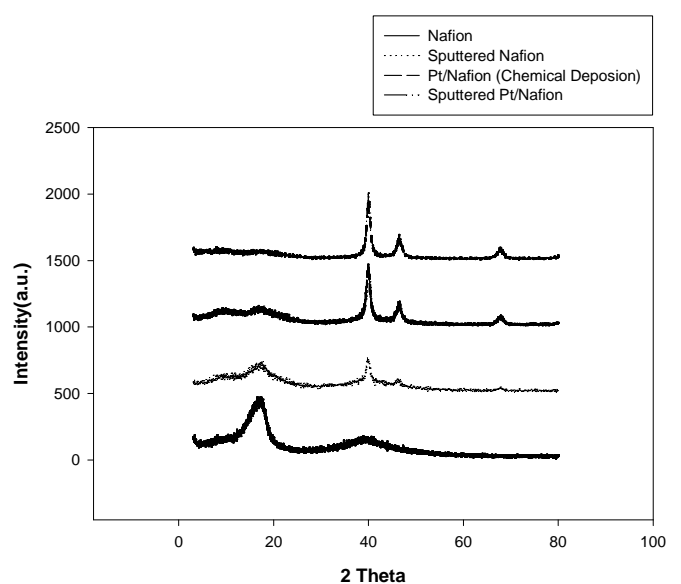


Fig. 2. XRD patterns of Pt/Nafion composites

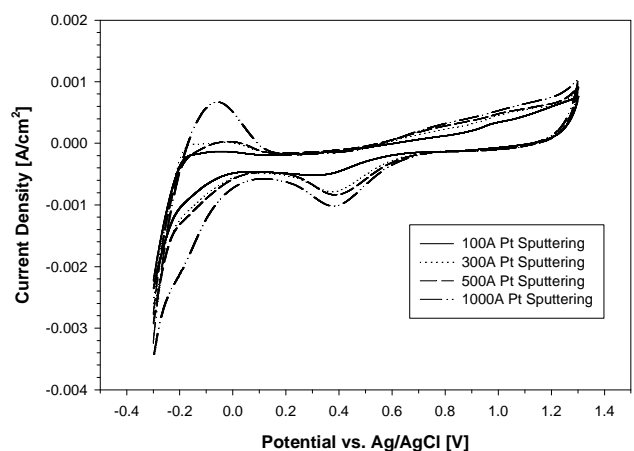


Fig. 3. Cyclic Voltammogram of sputtered Pt on Nafion with various thickness (25 °C, 0.5 M H_2SO_4 , scan rate 50mV/s)