Peranan reduktor dan tingkat keasaman reaksi dalam sintesis elektrokatalis Pt/CNT terhadap kinerja Proton Exchange Membran Fuel Cell (PEMFC) = The role of the reducing agent and the acidity levels on electrocatalyst-based Pt/CNT synthesis to The Performance of Exchange Membran Fuel Cell (PEMFC).

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Abstrak

Pemanfaatan carbon nanotube (CNT) sebagai support elektrokatalis Pt dalam sistem Proton Exchange Membran Fuel Cell (PEMFC) memberikan potensi yang cukup besar menggantikan karbon amorf untuk meningkatkan efisiensi pemanfaatan Pt yang cenderung mahal. Pembuatan elektrokatalis berbasis CNT telah berhasil dilakukan dengan mendeposisikan nanopartikel Pt pada permukaan Multi Wall Carbon Nanotube (MWCNT) melalui proses presipitasi menggunakan etilen glikol (EG). Optimalisasi ukuran dan distribusi nanopartikel Pt pada permukaan MWCNT dilakukan dengan variasi keasaman reaksi (pH 4, 7, dan 13) dengan variasi reduktor (NaBH4 dan LiAlH4). Hal ini dilakukan untuk mengatur kondisi sintesis yang dapat menghasilkan elektrokatalis dengan pemuatan (loading) Pt yang tinggi. Ukuran dan distribusi Pt sebagai kontributor utama terhadap pemuatan Pt digunakan sebagai indikator yang akan mempengaruhi kinerja PEMFC. Deposisi Pt pada permukaan MWCNT terfungsionalisasi melalui prekursor hexachloroplatinic acid (H2PtCl6) dilakukan melalui metode presipitasi dengan variasi reduktor dan variasi keasaman reaksi. Karakterisasi elektrokatalis dilakukan menggunakan Difraktometer Sinar-X (XRD), Scanning Electron Microscope (SEM) dengan Energy Dispersive X-Ray Spectroscopy (EDS), Transmission Electron Microscope (TEM), Particle Size Analyzer (PSA), Raman Spectroscopy dan Surface Area Analyzer (SAA). Sedangkan uji kinerja dilakukan dengan menyiapkan konfigurasi membrane electrode assembly (MEA) berbasis elektrokatalis Pt/CNT yang telah dibuat.
Berdasarkan hasil karakterisasi yang telah dilakukan, reduktor NaBH4 memberikan pemuatan Pt yang tinggi yaitu 31,99 % dari hasil analisis kuantitatif menggunakan EDS. Hasil analisis difraksi sinar-X dan TEM menunjukkan terbentuknya nanopartikel Pt pada permukaan CNT dengan ukuran sebesar 3 hingga 4 nm. Kecenderungan aglomerasi menjadi 6-9 nm terjadi pada pH menyebabkan perubahan rasio R=ID/IG MWCNT dari 1,45 (pH 4) menjadi 1,18 (pH 13) sebagai faktor yang dipengaruhi oleh distribusi Pt pada cacat MWCNT dimana pH 13 menghasilkan distribusi Pt yang lebih tinggi. Disamping itu luas permukaan Pt/CNT antara 87,182-110,611 m2/g telah terbukti lebih besar daripada Pt/C komersial. Hasil pengujian stack fuel cell dengan Membrane Electrode Assembly (MEA) berbasis elektrokatalis Pt/CNT menunjukkan kurva viii viii polarisasi dari Pt-CNT dengan reduktor NaBH4 dan LiAlH4 pada pH 13 sebesar 43 mW/cm2 dan 17 mW/cm2.
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The utilization of carbon nanotube (CNT) as support of electrocatalyst Pt in Proton Exchange Membrane Fuel Cell (PEMFC) was highly potential to replace amorphous carbon to increase the efficiency of Pt utilization which tent to be expensive. The Pt/CNT-based electrocatalyst has been successfully synthesized by depositing Pt nanoparticles on Multi Wall Carbon Nanotube (MWCNT) surfaces via precipitation process using ethylene glycol (EG). Optimizing of Pt nanoparticles size and distribution on the MWCNT

surface has been conducted under various acidity (pH 4, 7, and 13) with varying of reducing agent (NaBH4 and LiAlH4). This controlled synthesis condition is conducted to get optimized Pt loading on the electrocatalyst system. The size and distribution of Pt as the main contributor of Pt loading were used as the main indicator that will affect the performance of Proton Exchange Membrane Fuel Cell (PEMFC). Pt deposition on the functionalized-MWCNT surface from hexachloroplatinic acid (H2PtCl6) precursor was carried out using precipitation method with varying of both reducing agent and acidity levels. Electrocatalyst was characterized by using different testing instruments such as X-Ray Diffractometer (XRD), Scanning Electron Microscope (SEM) powered by Energy Dispersive X-Ray Spectroscopy (EDS), Transmission Electron Microscope (TEM), Particle Size Analyzer (PSA), Raman Spectroscopy and Surface Area Analyzer (SAA). Performance as a catalyst in PEMFC was tested by preparing a membrane electrode assembly (MEA)-based Pt/CNT.

According to characterization results, the combination of the highest acidity levels (pH=13) and reducing agent NaBH4 showed the highest Pt loading around 31.99% reflected from XRD results and supported by quantitative results using EDS. The result of XRD analysis and TEM observation showed that Pt-nanoparticles of size around 3-4 nm were deposited on CNT surfaces. The agglomeration of Pt nanoparticles occurred in the highest acidity levels (pH=13) where its size was changed to 6-9 nm. It contributed to the performance of electrocatalyst. The ratio (R= ID/IG) of MWCNT is decreased from 1.45 (pH=4) to 1.18 (pH=13) with the increasing of acidity levels as one of factor which was influenced by Pt distribution on the defect of CNT where the highest acidity levels (pH=13) give well Pt distribution on CNT surface. Subsequently, the surface area of Pt/CNT is about 87.182-110.611 m2/g which proved better than commercial Pt/C. The result of stack fuel cell with membrane electrode assembly (MEA-based Pt/CNT showed that polarization curve of Pt/CNT using reducing agent NaBH4 dan LiAlH4 under the highest acidity levels (pH=13) is about 43 mW/cm2 and 17 mW/cm2 respectively.