SINTESIS DAN KARAKTERISASI MATERIAL PALADIUM-KOBALT TERDEPOSISI PADA GRAFENA OKSIDA TEREDUKSI SEBAGAI KATALIS UNTUK REAKSI REDUKSI OKSIGEN

DYAH AYU FATMAWATI
19/451058/SPA/00708

INTISARI

Penelitian mengenai sintesis dan karakterisasi material paladium-kobalt terdeposisi pada grafena oksida tereduksi sebagai katalis untuk reaksi reduksi oksigen telah berhasil dilakukan. Penelitian ini bertujuan untuk mempelajari pengaruh rasio berat oksidator $KMnO_4$:grafit terhadap karakter grafena oksida (GO), pengaruh metode pemanasan reduksi terhadap karakter grafena oksida tereduksi (RGO), pengaruh jenis agen penstabil terhadap karakter PdCo/RGO, serta pengaruh karakter PdCo/RGO terhadap aktivitas reaksi reduksi oksigen (ORR).

Material GO disintesis menggunakan metode Tour dengan variasi rasio berat $KMnO_4$:grafit sebesar 0,5; 2,0; 3,5; 5,0; dan 6,0. Material RGO disintesis dengan variasi metode pemanasan reduksi: *hotplate* selama 2 jam, sonokimia selama 30 menit, dan *microwave* selama 4 menit. Material PdCo/RGO disintesis menggunakan metode ko-reduksi dengan variasi jenis agen penstabil: cetilmetilamonium bromida (CTAB), heksametilentetramin (HMTA), dan kombinasi CTAB-HMTA. Material yang diperoleh dikarakterisasi menggunakan instrumentasi XRD, FTIR, Raman, UV-Vis, TGA, SAA, SEM-EDX, TEM, dan LCR meter. Semua material PdCo/RGO diuji aktivitas ORRnya menggunakan *potentiostat*-RDE.

Hasil penelitian menunjukkan bahwa rasio berat $KMnO_4$:grafit optimal untuk GO adalah 3,5 (GO-3,5) dengan karakter material: memiliki 8-9 lapisan grafena dengan jarak antar lapisan sebesar 0,85 nm dari hasil XRD. Metode pemanasan reduksi optimal untuk RGO adalah *hotplate* 2 jam (RGO-HP) dengan karakter material: memiliki 3 lapisan grafena dengan jarak antar lapisan sebesar 0,37 nm dari hasil XRD, rasio I_D/I_G sebesar 1,57 dari hasil Raman, luas permukaan spesifik sebesar 137 m^2/g dengan rerata diameter pori dan volume pori sebesar 4,09 nm dan 0,17 cm^3/g dari hasil SAA, serta memiliki nilai konduktivitas listrik sebesar 539,1 S/m. Jenis agen penstabil optimal untuk PdCo/RGO adalah HMTA (PdCo-H/RGO) dengan karakter material memiliki nanopartikel PdCo dengan ukuran terkecil, bentuk paling seragam, dan dispersi terbanyak pada permukaan RGO. Uji elektrokatalitik ORR menunjukkan bahwa PdCo-H/RGO memiliki aktivitas dengan jumlah transfer elektron sebesar 3,64 yang memenuhi kaidah 1-*pathway* ORR. Uji stabilitas katalis menunjukkan PdCo-H/RGO memiliki ketahanan yang relatif tinggi dengan pergeseran negatif $E_{1/2}$ sebesar 57,6 mV.

Kata kunci: paladium, kobalt, cetilmetilamonium bromida, heksametilentetramin, grafena oksida tereduksi, reaksi reduksi oksigen

SYNTHESIS AND CHARACTERIZATION OF PALLADIUM-COBALT DEPOSITED ON REDUCED GRAPHENE OXIDE MATERIAL AS CATALYST FOR OXYGEN REDUCTION REACTION

DYAH AYU FATMAWATI
19/451058/SPA/00708

ABSTRACT

Research on the synthesis and characterization of palladium-cobalt deposited on reduced graphene oxide material as catalyst for oxygen reduction reaction has been successfully carried out. This research aims to investigate the effect of the weight ratio of $KMnO_4$ oxidizing agent:graphite on the character of graphene oxide (GO), the effect of reduction heating method on the character of reduced graphene oxide (RGO), the effect of stabilizer agent type on the character of PdCo/RGO, and the effect of the PdCo/RGO character on the activity of the oxygen reduction reaction (ORR).

The GO material was prepared by the Tour method with various $KMnO_4$:graphite weight ratios of 0.5, 2.0, 3.5, 5.0, and 6.0. The RGO material was synthesized with various reduction heating methods: hotplate for 2 hours, sonochemical for 30 minutes, and microwave for 4 minutes. The PdCo/RGO material was synthesized by the co-reduction method with various stabilizer agent types of cetyltrimethylammonium bromide (CTAB), hexamethylenetetramine (HMTA), and a combination of CTAB-HMTA. Materials obtained were characterized using XRD, FTIR, Raman, UV-Vis, TGA, SAA, SEM-EDX, TEM, and LCR meter. The PdCo/RGO materials were tested for their catalytic activity in ORR by a potentiostat with LSV method.

The research results showed that the optimal weight ratio of $KMnO_4$:graphite for GO was 3.5 (GO-3.5) with its character having 8-9 layers of graphene with an interlayer distance of 0.845 nm from XRD result. The optimal reduction heating method for RGO is hotplate (RGO-HP) with its character having 3 layers of graphene with an interlayer distance of 0.37 nm from XRD result, an I_D/I_G ratio of 1.57 from Raman result, a specific surface area of 137 m^2/g with the average pore diameter and pore volume were 4.09 nm and 0.17 cm^3/g from SAA result, and electrical conductivity of 539.1 S/m. The optimal stabilizer agent type for PdCo/RGO is HMTA (PdCo-H/RGO) with its character having PdCo nanoparticles with the smallest size, the most uniform shape, and the most dispersion on the RGO surface. The ORR catalytic test showed that PdCo-H/RGO had the activity with the number of electron transfers of 3.64 which follow the 1-pathway rule of the ORR. The catalyst stability test showed that PdCo-H/RGO had relatively high durability with an $E_{1/2}$ negative shift of 57.6 mV.

Keywords: palladium, cobalt, cetyltrimethylammonium bromide, hexamethylenetetramine, reduced graphene oxide, oxygen reduction reaction