

Sintesis dan Aplikasi rGO dan GOH sebagai Pemodifikasi Elektroda pada Elektrodegradasi Zat Warna *Safranine O* dan *Crystal violet*

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INTISARI

Elektroda PbO_2 memiliki kinerja elektrodegradasi yang terbatas akibat rendahnya efisiensi dan stabilitas. Penelitian ini bertujuan mempelajari pengaruh modifikasi elektroda PbO_2 menggunakan *reduced graphene oxide* (rGO) dan grafena terfungsionalisasi hidroksil (GOH) terhadap kinerja elektrodegradasi zat warna *safranine O* dan *crystal violet*. Sintesis rGO dari arang aktif komersial dilakukan menggunakan metode hidrotermal. Sintesis GOH dari grafit dilakukan menggunakan kombinasi metode eksfoliasi elektrokimia, hidrotermal, dan ultrasonikasi. Modifikasi elektroda dilakukan menggunakan deposisi elektroforetik. rGO, GOH dan elektroda modifikasi dikarakterisasi menggunakan spektrofotometri *ultra violet-visible* (UV-Vis), spektrometer *Fourier Transform Infra-red* (FTIR), *X-Ray diffractometer* (XRD), spektrometri Raman, *Scanning Electron Microscopy-Energy Dispersive X-ray* (SEM-EDX), dan *Transmission Electron Microscopy* (TEM). Aktivitas elektrokatalitik diuji melalui voltametri siklik. Hasil karakterisasi menunjukkan bahwa rGO dan GOH terbentuk pada proses hidrotermal pada suhu 190°C selama 12 jam dengan komposisi (C 82,87%; O 17,13%) dan (C 67,08 %; O 32,92%). Modifikasi elektroda menghasilkan PbO_2/rGO dan PbO_2/GOH dengan aktivitas elektrokatalitik 72,73% dan 73,31% lebih tinggi dari pada PbO_2 . Modifikasi kedua elektroda dapat mengurangi pelarutan Pb 69,01% dan 71,33%. Elektrodegradasi *safranine O* menggunakan PbO_2/rGO menghasilkan penurunan absorbansi, BOD, dan COD berturut-turut 99,00%, 96,77%, dan 97,00%, dengan rerata peningkatan efisiensi degradasi 38,21%. Elektrodegradasi *crystal violet* menggunakan PbO_2/GOH menghasilkan penurunan absorbansi, BOD, dan COD berturut-turut 99,36%, 94,08%, dan 95,79% dengan rerata peningkatan efisiensi degradasi 30,12%. Aplikasi kedua elektroda pada air limbah menghasilkan rerata peningkatan efisiensi degradasi 35,33% dan 35,55%. Uji kinerja penggunaan ulang menunjukkan kedua elektroda dapat digunakan 10 kali. Hasil ini menunjukkan bahwa modifikasi dengan rGO dan GOH meningkatkan efisiensi degradasi dan stabilitas elektroda PbO_2 .

Kata kunci: grafena, eksfoliasi elektrokimia, ultrasonikasi, hidrotermal, elektrodegradasi

Synthesis and Application of rGO and GOH as Electrode Modifiers in Electrodegradation of *Safranine O* and *Crystal violet* Dye

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ABSTRACT

PbO₂ electrodes have limited electrodegradation performance due to low efficiency and stability. This study aims to investigate the effect of modifying PbO₂ electrodes using reduced graphene oxide (rGO) and hydroxyl-functionalized graphene (GOH) on the electrodegradation performance of *safranine O* and *crystal violet* dyes. rGO was synthesized from commercial activated charcoal using a hydrothermal method. GOH was synthesized from graphite using a combination of electrochemical exfoliation, hydrothermal, and ultrasonication methods. Electrode modification was performed using electrophoretic deposition. rGO, GOH, and modified electrodes were characterized using ultraviolet-visible (UV-Vis) spectrophotometry, Fourier Transform Infra-red (FTIR) spectrometry, X-Ray diffractometer (XRD), Raman spectrometry, Scanning Electron Microscopy-Energy Dispersive X-ray (SEM-EDX), and Transmission Electron Microscopy (TEM). Electrolytic activity was tested through cyclic voltammetry. Characterization results showed that rGO and GOH were formed in a hydrothermal process at 190 °C for 12 hours with compositions of (C 82.87%; O 17.13%) and (C 67.08%; O 32.92%). Modification of the electrode produced PbO₂/rGO and PbO₂/GOH with electrocatalytic activities 72.73% and 73.31% higher than PbO₂. Modification of both electrodes reduced Pb dissolution by 69.01% and 71.33%, respectively. Electrodegradation of *safranine O* using PbO₂/rGO resulted in a decrease in absorbance, BOD, and COD by 99.00%, 96.77%, and 97.00%, respectively, with an average increase in degradation efficiency of 38.21%. Electrodegradation of *crystal violet* using PbO₂/GOH resulted in a decrease in absorbance, BOD, and COD by 99.36%, 94.08%, and 95.79%, respectively, with an average increase in degradation efficiency of 30.12%. The application of both electrodes to wastewater resulted in an average increase in degradation efficiency of 35.33% and 35.55%. Reuse performance tests showed that both electrodes could be used 10 times. These results indicate that modification with rGO and GOH improves the degradation efficiency and stability of PbO₂ electrodes.

Keywords: graphene, electrochemical exfoliation, ultrasonication, hydrothermal, electrodegradation