Carbon Nanotube-Modified MnO_2: An Efficient Electrocatalyst for Oxygen Reduction Reaction

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In this work, manganese dioxide/carbon nanotube (MnO_2/CNT) have been synthesized by sonochemical-coprecipitation method and demonstrated that it could be an effective electrocatalyst for oxygen reduction reaction (ORR). Moreover, the effect of CNT inclusion with MnO_2 was also investigated for ORR. The physical and electrochemical properties of the MnO_2/CNT were examined by powder X-ray diffraction (XRD), Fourier Transform Infrared (FT-IR) spectroscopy, Brunauer-Emmett-Teller (BET), Transmission Electron Microscopy (TEM), Field Emission Scanning Electron Microscopy/Energy Dispersive X-ray (FESEM/EDX), Cyclic Voltammetry (CV), Electrochemical Impedance Spectroscopy (EIS), Mott-Schottky and Rotating Disk Electrode (RDE) analysis. CV showed higher currents for the ORR in MnO_2/CNT than CNT; however, ORR current dropped when the MnO_2 loading was increased from 20–40%. The EIS analysis showed that charge-transfer resistance for MnO_2/CNT was significantly lower compared to the MnO_2 indicating that MnO_2 has good contact with CNT and the composite possess high electrical conductivity. Mott-Schottky results demonstrated that incorporation of CNT into MnO_2 resulted in producing larger electron density in n-type MnO_2/CNT compared to MnO_2 which is liable for efficient electron donation from the Mn^{3+} to adsorbed oxygen in the rate determining step. RDE results showed that MnO_2/CNT follows $4e^-$ transfer pathway, indicating its ability to act as an effective ORR electrocatalyst.