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Development of a Sensitive Electrochemical Sensor Based on Carbon Dots and Graphitic Carbon Nitride for the Detection of 2-Chlorophenol and Arsenic

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Abstract : Arsenic and 2-chlorophenol are priority pollutants that pose serious health threats to humans and ecology. An electrochemical sensor, based on graphitic carbon nitride (g-C_3N_4) and carbon dots (CDs), was fabricated and used for the determination of arsenic and 2-chlorophenol. The g-C_3N_4/CDs nanocomposite was prepared via microwave irradiation heating method and was dropped-dried on the surface of the glassy carbon electrode (GCE). Transmission electron microscopy (TEM), X-ray diffraction (XRD), photoluminescence (PL), Fourier transform infrared spectroscopy (FTIR), UV-Vis diffuse reflectance spectroscopy (UV-Vis DRS) were used for the characterization of structure and morphology of the nanocomposite. Electrochemical characterization was done by electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV). The electrochemical behaviors of arsenic and 2-chlorophenol on different electrodes (GCE, CDs/GCE, and g-C_3N_4/CDs/GCE) was investigated by differential pulse voltammetry (DPV). The results demonstrated that the g-C_3N_4/CDs/GCE significantly enhanced the oxidation peak current of both analytes. The analytes detection sensitivity was greatly improved, suggesting that this new modified electrode has great potential in the determination of trace level of arsenic and 2-chlorophenol. Experimental conditions which affect the electrochemical response of arsenic and 2-chlorophenol were studied, the oxidation peak currents displayed a good linear relationship to concentration for 2-chlorophenol (R^2=0.948, n=5) and arsenic (R^2=0.9524, n=5), with a linear range from 0.5 to 2.5µM for 2-CP and arsenic and a detection limit of 2.15µM and 0.39µM respectively. The modified electrode was used to determine arsenic and 2-chlorophenol in spiked tap and effluent water samples by the standard addition method, and the results were satisfying. According to the measurement, the new modified electrode is a good alternative as chemical sensor for determination of other phenols.

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