Development of a Boron-Doped Diamond Electrode for the Simultaneous Detection of Cd^{2+} and Pb^{2+} in Water

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Mercury film electrodes used in in-situ monitoring systems suffer from the drawbacks of secondary pollution and attenuation. To overcome these problems, a boron-doped diamond (BDD) film electrode was developed that was non-polluting and could be used for simultaneous detection and long durations. The concentrations of Cd^{2+} and Pb^{2+} in mixed solution were measured simultaneously, and the detection performances of the mercury film and BDD electrodes were systemically compared, to evaluate the feasibility of replacing mercury film electrodes with BDD electrodes. The effects of enrichment time and electrode surface state on the stripping peak currents of Cd^{2+} and Pb^{2+} were investigated. Optimum conditions were an enrichment time of 200 s and a hydrogen terminated electrode surface state. The optimized BDD electrode exhibited good performance characteristics: 1) The linear relationship between the ion concentration and the peak current was excellent (linear correlation coefficients (R^2) of the calibration curves for Cd^{2+} and Pb^{2+} were 0.995 and 0.998, respectively). The spiked recovery ranges of Cd^{2+} and Pb^{2+} in three spike experiments were 93.5% to 99.4% and 93.7% to 101.3%, respectively. 2) The detection limits for Cd^{2+} and Pb^{2+} were low, 3.39 $\mu\text{g/L}$ and 3.62 $\mu\text{g/L}$, respectively. The BDD electrode had good reproducibility: relative standard deviations (RSD) of Cd^{2+} and Pb^{2+} obtained from 7 replicate experiments were 1.603% and 3.819%, respectively. After comprehensive data comparison of the detection performance for mercury film and BDD electrodes, it was concluded that the BDD electrode could replace mercury film electrodes in in-situ monitoring systems, having the advantage of allowing simultaneous detection, being non-polluting, and able to function for long-durations.

Keywords: Boron-Doped Diamond Film; Mercury Film Electrode; Heavy Metal Ions; Square Wave Anodic Stripping Voltammetry

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