Role of Br⁻ on the Formation of a Bismuth Nanodendrite Structure and Its Use as an Electrochemical Sensor for Heavy Metal Detection

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Bismuth nanodendrites (BiNDs) were fabricated by simple, one-step electrodeposition of Bi and employed for simultaneous detection of Cd²⁺ and Pb²⁺ in water samples. To construct reliable BiNDs on a glassy carbon electrode (BiND@GCE) without agglomeration and structural imperfections, Br⁻ was used as a co-reagent to prohibit agglomeration of Bi. The simultaneously generated hydrogen bubbles from H₂ evolution at the surface during Bi deposition could largely cover potential nucleation sites and subsequently suppress the fast agglomeration of Bi. Britton-Robinson buffer, which allowed the formation of BiPO₄ on the surface, was used to ensure the stability of the BiNDs during the electrochemical scans. When BiND@GCE was used to measure Cd²⁺ and Pb²⁺ concentrations in aqueous standard samples (concentration range: 2–270 ppb), the achieved limits of detection (LODs) were 0.09 (Cd²⁺) and 0.05 (Pb²⁺) ppb. Next, when real field samples obtained from the river and sea were analyzed with BiND@GCE and the subsequent results were compared with those obtained using inductively coupled plasma mass spectrometry, the measurements were accurate, with a recovery range of 89.9–99.3%. Overall, BiNDs represent a versatile electrochemical sensing material, especially for on-site water analysis, with low cost and no serious concern of environmental contamination.

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