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Highly efficient electrochemical ascorbic acid determination via a cooperative catalytic effect of dendritic Bi/Bi_2O_3 junctions and oxygen vacancies

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Abstract

This study developed an electrochemical sensor for ascorbic acid (AA) using dendritic nanostructured (DN) bismuth/bismuth oxide thin films with oxygen-deficient (SOD) surfaces (SOD-DN Bi/Bi_2O_{3-x} thin films) that were successfully fabricated through electrodeposition on fluorine-doped tin oxide (FTO) substrates. Using cyclic voltammetry and amperometry, we assessed electrocatalytic activity in neutral media. The prepared SOD-DN Bi/Bi_2O_{3-x} thin film was used, for the first time, as electrodes in a highly sensitive and selective electrochemical AA sensor. The SOD-DN Bi/Bi_2O_{3-x} thin film with optimal characteristics was shown to be ultrasensitive in AA detection in neutral conditions, whereby high detection sensitivity ~ 2.30 μA $\mu M^{-1} cm^{-2}$ over a wide range of AA concentration ~ 0.01 μM to 1.0 mM and working potential range ~ 0.3–1.0 V vs. SCE. The results indicate that SOD-DN Bi/Bi_2O_{3-x} can provide large amounts of active reaction sites, thereby enhancing electrocatalytic activity and electrochemical sensitivity. Due to this, it is a unique electrochemical sensor able to detect AA without interference from DA, UA, or other contaminants. A further amperometric test demonstrated that this sensor was capable of detecting AA even under conditions of dopamine and uric acid. Accordingly, the proposed sensor provides a promising avenue for developing electrochemical sensing for AA determination. This strategy introduces a novel type of high-efficiency electrocatalyst for ultrasensitive detection of medical and environmental biomarkers.