Improving Photoelectrochemical Performance of PbX (X=S, Se, Te) thin Films by Electro-oxidation for Cu²⁺ Detection

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This paper proposes an electro-oxidation method to improve the photoelectrochemical performance of PbX (X=S, Se, Te) thin films electrodeposited onto indium tin oxide (ITO)-coated glass. The PbX/ITO electrode was electro-oxidized using cyclic voltammetry scanning in the potential range of 0-1 V in NaNO₃ solution. The photocurrent enhancement was observed in the electro-oxidized PbS/ITO, PbSe/ITO, PbTe/ITO electrodes. Among these three electrodes, the electro-oxidized PbSe/ITO electrode exhibited the strongest, most stable and reproducible photocurrent. The morphology and composition of the electro-oxidized PbSe/ITO electrode were investigated by scanning electron microscopy (SEM) and X-ray powder diffraction (XRD). These results indicate that Se was formed on the surface of the PbSe thin film after the electro-oxidation. The enhancement of photocurrent of the PbSe/ITO electrode could be attributed to the formation of Se-PbSe interface. In a HAc-NaAc buffer solution (pH 5.0), the Se-PbSe/ITO electrode exhibited a good photocurrent response to Cu²⁺ ions, with a dynamic range from 10 nM to 100 μM and the limit of detection of 1.2 nM. The common metal ions at 100 times excess to Cu²⁺ (10 nM) did not interfere with the detection of Cu²⁺ within an error of 10%. The proposed method was applied for the detection of Cu²⁺ in municipal tap, river, and pond water samples, and the results are consistent with those obtained by atomic absorption spectrometry (AAS).

Keywords: Photoelectrochemical performance, Electro-oxidation, PbSe, Se, Cu²⁺ Detection

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