Influence of Molecular Structure of Imidazolium Based Ionic Liquids on the Electrochemical Oxidation Performances of Resulting PbO₂ Deposits

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The PbO₂ coatings were electrodeposited on titanium sheet from aqueous solution containing lead nitrate and imidazolium based ionic liquids (ILs) additive. Effects of molecular structure of ILs on electro-catalytic activities of resulting PbO₂ electrodes were investigated. Electrochemical treatment of simulated wastewater containing phenol was carried out to investigate the electro-catalytic activities of the PbO₂ electrodes modified by ILs. High performance liquid chromatography (HPLC) was employed to determine the amount of hydroxyl radicals ($\cdot\text{OH}$) generated on the electrodes by using salicylic acid (SA) as a probe. The electrochemical properties of the samples were investigated by polarization curves tests. The surface structure and wetting ability of the samples were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) and contact angle test respectively. The results showed that the electro-catalytic activities of PbO₂ electrodes modified by [Emim]BF₄ were significantly higher than that of PbO₂ electrodes modified by [Emim]Br or [Emim]PF₆. With BF₄⁻ fixed, the improvement order for the activity of modified PbO₂ electrodes was as follows: [Bmim]BF₄>[Emim]BF₄>[Hmim]BF₄. XRD patterns and SEM micrographs showed a highly textured structure and controlled morphology of the PbO₂ coatings by ILs modification. Both the anions and cation chain lengths of imidazolium based ILs had a significant effect on the surface properties and electro-catalytic activities of resulting PbO₂ electrodes, with the influence of the former being more prominent than that of the latter. The modification may be attributed to the adsorption of ILs molecule on the anode surface during the electrodeposition of PbO₂ coating. Meanwhile, the higher COD removal efficiency on PbO₂ electrodes modified by [Bmim]BF₄ can be attributed to its preferential orientation along (110) plane as well as its larger specific surface area and more active sites for the generation of hydroxyl radical. Furthermore, [Bmim]BF₄ had the most significant positive impact on the reusability and stability of PbO₂ coatings.

Keywords: PbO₂ electrodes; ionic liquids; electrochemical oxidation; phenol degradation; hydroxyl radicals ($\cdot\text{OH}$), COD removal

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