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Structural and Electrochemical properties of recycled active electrodes from spent lead acid battery and modified with different manganese dioxide contents

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Abstract

Samples of MnO_2 incorporated into active electrodes structure of the disassembled car batteries were prepared by classical melt-quenching method. The effect of MnO_2 concentration on host network were investigated by X-ray diffraction (XRD) analysis, InfraRed (IR), UltraViolet-Visible (UV-Vis), Photoluminescence (PL) and Electron Paramagnetic Resonance (EPR) spectroscopy, measurements of Cyclic Voltammetry (VC).

X-ray diffractograms show the presence of the metallic lead in the cubic structure and small amounts of PbO_2 crystalline phase with the orthorhombic structure in the metallic samples.

Combining all of the outputs from different characterizations, we can conclude that the amount of MnO_2 incorporated into structure of the recycled active electrodes has effect on the number of non-bridging oxygen atoms that determines the role of MnO_2 as a modifier/network former. At lower MnO_2 contents, the doping breaks Pb-O-Pb bonds producing the formation of $[MnO_6]$ structural units in which the Mn^{+2} ions are in octahedral symmetry, gap energy value increases and the effect of luminescence is quenched. At higher MnO_2 content, MnO_2 plays a network former role, joins the vitroceramic network as $[MnO_4]$ and $[MnO_6]$ structural units and the PL intensity increases.

The sample doped with small MnO_2 content (x=5mol%) used as working electrode in the measurements of cyclic voltammetry shows a good reversibility of the voltammogram, also improved the electrochemical properties, namely an increased stability in acidic electrolyte environments and offers an alternative for obtaining of electrodes for rechargeable batteries.

Keywords: lead-acid battery, MnO_2, lead recycling, XRD, FTIR, UV-Vis, PL and RES spectroscopy, cyclic voltammetry.