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Investigation of the synergistic effect of $Fe_{1.9}V_{0.1}O_3$ nanoparticles as modifiers of Printex L6 Carbon to oxygen reduction reaction for H_2O_2 Electrogeneration

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Hydrogen peroxide (H_2O_2) is an oxidizing compound that has many applications, particularly in the treatment of industrial effluents [1]. Electrochemical technology has been developed to produce H_2O_2 *in situ* through the oxygen reduction reaction (ORR) via 2 electrons pathway, using carbonaceous materials such as Printex L6 carbon (PL6C) [2]. In order to improve the high selectivity and efficiency of PL6C for H_2O_2 electrogeneration, this work studies the synthesis, structural and electrochemical characterization of $Fe_{1.9}V_{0.1}O_3$ nanoparticles (NPs) and used as modifier of PL6C in order to increase the efficiency of ORR via 2 electrons. The NPs were obtained using the Fe^{2+}, Fe^{3+} and V^{5+} salts by co-precipitation method. These materials were characterized by X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM-FEG) and transmission electron microscopy (TEM) to determine their crystal structures and morphological analysis. The X-ray photoelectron spectroscopy (XPS), electrochemically active area (EQSA) and the zero charge point (pH_{ZPC}), as well as the contact angle were also determined to understanding the interaction between the NPs and the PL6C. In addition, PL6C modified with $Fe_{1.9}V_{0.1}O_3$ NPs was analyzed by Cyclic Voltammetry (CV) and Linear Voltammetry (LV), with a rotating ring-disk electrode system (RRDE). These analyses were carried out at pH 3.0 and 9.0 to study the electrocatalytic activity, determine the average selectivity for H_2O_2 formation via ORR and the number of average electrons involved in the process. The results of the structural analysis indicate the presence of two oxide phases: maghemite (Fe_2O_3) and hematite (γ-Fe_2O_3), with an average size of 8.0 mm (± 0.5) and spherical morphology, similar to PL6C. The surface interactions indicate a greater interaction of the modified carbon with the electrolyte and the charges present in the medium, based on the decrease in contact angle (from 113º to 99º) and increase of specific capacitance (from 75.6 $\mu F.cm^{-2}$ to 109.2 $\mu F.cm^{-2}$) of the 98% PL6C@2% $Fe_{1.9}V_{0.1}O_3$ catalytic coatings. In addition, this composition showed an increase in selectivity for H_2O_2 production by ORR when compared to PL6C, at both pH (6.2 and 16.2%, respectively).

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References:

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