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Synthesis and characterization of the composite $La_{0.50}Li_{0.50}TiO_3$/PANI for application in lithium batteries

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Abstract – In order to improve the electron conductivity of lithium lanthanum titanate powder, a composite based in $La_{0.50}Li_{0.50}TiO_3$/polyaniline was synthesized. The crystallization of the phases and the structural characterization were evaluated by XRD (Fig. 1). The powder morphology was analyzed by SEM-FEG (Fig. 2). Electrochemically, powder and composite were characterized by means analyses of chronopotentiometry.

Li ion-conducting materials have been widely studied in the last few years because of their potential applications as solid electrolytes in high energy batteries and other electrochemical devices [1]. The perovskite-type lithium lanthanum titanate, $La_{2/3-x}Li_{3x}TiO_3$, is well known to be a high lithium ionic conductor having bulk conductivity of 10^{-3} Scm^{-1} at room temperature for x = 0.10 [2]. Despite this high conductivity, the use of ceramic materials as electrodes has been limited by their brittle nature, which spurred the research for the formation the hybrid materials by mixing between the ceramics and flexible materials as the organic conductors [3, 4].

The polyaniline has been the polymeric conductor most studied in recent years. So, this research presents the synthesis of lithium lanthanum titanate ($La_{0.50}Li_{0.50}TiO_3$) powder by polymeric precursor method. Also, it is discussed the synthesis of $La_{0,50}Li_{0,50}TiO_3$/polyaniline composite in order to obtain electrochemical properties compatible for application in rechargeable lithium batteries. The crystallization of phases and the structural characterization were evaluated by XRD. Powder morphology was analyzed by SEM-FEG. Electrochemically, powder and composite were characterized by chronopotentiometry technique.

To define with accuracy the temperature that begins the crystallization process, $La_{0.50}Li_{0.50}TiO_3$ powders were heated between 350ºC and 800ºC for 3h. XRD patterns indicated the evolution of the crystallization process with increase in calcination temperature, indicating a correlation between the process of phase crystallization and organic fraction elimination. The images obtained by SEM-FEG have shown the size of the particles as well as the interaction between powders and polyaniline.

The electrochemistry study was performed by means a Swagelok cell configuration using a $La_{0.50}Li_{0.50}TiO_3$ pellet as cathode, a mixture of lithium perchlorate, ethylene carbonate and dimethyl carbonate as a liquid electrolyte, and lithium as anode material. Another cell was prepared using a composite pellet as cathode. Charge-discharge curves revealed that deintercalation and intercalation processes of lithium ions are not fully reversible in the $La_{0.50}Li_{0.50}TiO_3$ structure. On the other hand, the $La_{0.50}Li_{0.50}TiO_3$/PANI composite demonstrated total reversibility of this process, even when are used higher conditions of current. It is evident, therefore, the best effort of the electrochemical cell when used the $La_{0.50}Li_{0.50}TiO_3$/PANI composite as material for the cathode.

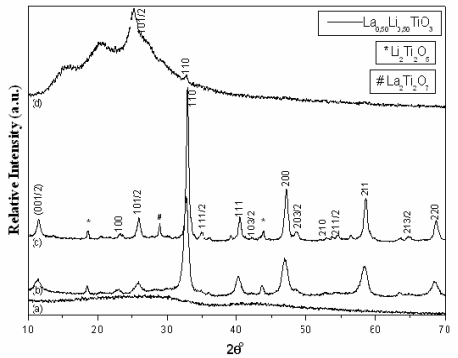

Figure 1: XRD patterns of LLTO heat treated at (a) 350℃; (b) 700℃; (c) 800℃ /3h and (d) LLTO/PANI composite.

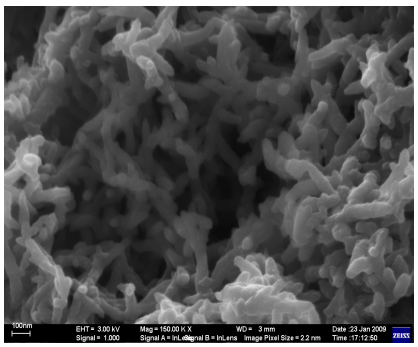

Figure 2: SEM-FEG micrograph of composite $La_{0,50}Li_{0,50}TiO_3$/polyaniline

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