

CONGRESO COLOMBIANO DE  
**V ELECTROQUÍMICA**  
 VIII SEMINARIO INTERNACIONAL DE  
**QUÍMICA APLICADA**  
 III Escuela Andino-Amazónica de Química  
 WORKSHOP QUÍMICA Y BIOLOGÍA DE HONGOS CON POTENCIAL BIOTECNOLÓGICO

**Synthesis and characterization of the V-doped  $\text{Li}_{0.3}\text{La}_{0.57}\text{Ti}_{1-x}\text{V}_x\text{O}_3$  solid electrolyte for all-solid state lithium-ion batteries.**

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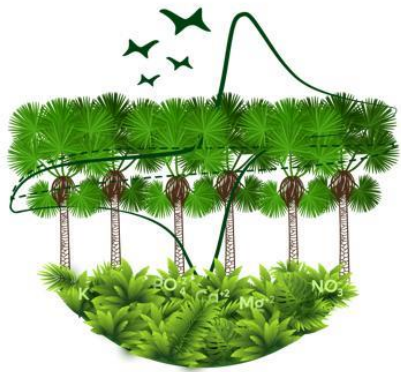
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**Abstract**

All-solid-state Li-ion batteries (ASSB) are one of the future alternatives for electrochemical energy storage, because it exhibits high energy density and safety. The solid electrolyte in the ASSB is a key element to improve the stability and reduce the flammability of lithium batteries [1]–[3]. Solid electrolytes can inhibit dendrites formation in lithium batteries during the charge-discharge processes extending the cycle life. Nevertheless, ASSBs industrial and commercial development have some challenges associated with the lower li-ion conductivity of solid electrolytes ( $1.0 \times 10^{-4} \text{S/cm}$ ) respect to the liquid electrolytes ( $1.0 \times 10^{-2} \text{S/cm}$ ), as well as high interfacial resistance due to the poor contact and interfacial reactions between the solid electrolyte and active materials.

Perovskite-type oxides [4] and sulfide-type [5] are promising solid electrolytes for all-solid-state batteries. Although the  $\text{Li}_{0.34}\text{La}_{0.51}\text{TiO}_{2.94}$  perovskite ( $\text{ABO}_3$ ) shows high chemical stability, high bulk ionic conductivity ( $1.0 \times 10^{-3} \text{S/cm}$ ), the total ionic conductivity is lower ( $1.96 \times 10^{-5} \text{S/cm}$ ) because of the grain boundary resistance, which reduces the  $\text{Li}^+$  transport [6]. To reduce the grain-boundary resistance it has been proposed the reduction the activation energy. Doping the B site of the perovskite structure with cations of smaller ionic radius is an alternative to decrease the interatomic bonding forces and improve the lithium conductivity [7].



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In this work, we present the synthesis of the  $\text{Li}_{0.34}\text{La}_{0.51}\text{Ti}_{1-x}\text{V}_x\text{O}_3$  ( $x=0-0.05$ ) using the sol-gel method followed by a sintering process at high temperature ( $1200^\circ\text{C}$ ) as a potential solid electrolyte for Li-ion batteries.

The XRD pattern indicates the formation of  $\text{Li}_{0.34}\text{La}_{0.51}\text{Ti}_{1-x}\text{V}_x\text{O}_3$  with perovskite structure in the orthorhombic crystalline system, showing a decrease of the unit cell with the vanadium doping, which can be attributed to the  $\text{V}^{+5}$  substitution, which has an ionic radius ( $0.54\text{\AA}$ ), lower than  $\text{Ti}^{+4}$  ( $0.605\text{\AA}$ ) in B cation of perovskite structure. The solid electrolyte  $\text{Li}_{0.34}\text{La}_{0.51}\text{TiO}_3$  without vanadium exhibits the highest total ionic conductivity  $4.54 \times 10^{-5}\text{S/cm}$ , and the  $\text{Li}_{0.34}\text{La}_{0.51}\text{Ti}_{0.98}\text{V}_{0.02}\text{O}_3$  exhibits the best grain conductivity ( $7.43 \times 10^{-4}\text{S/cm}$ ).

### Graphical Abstract

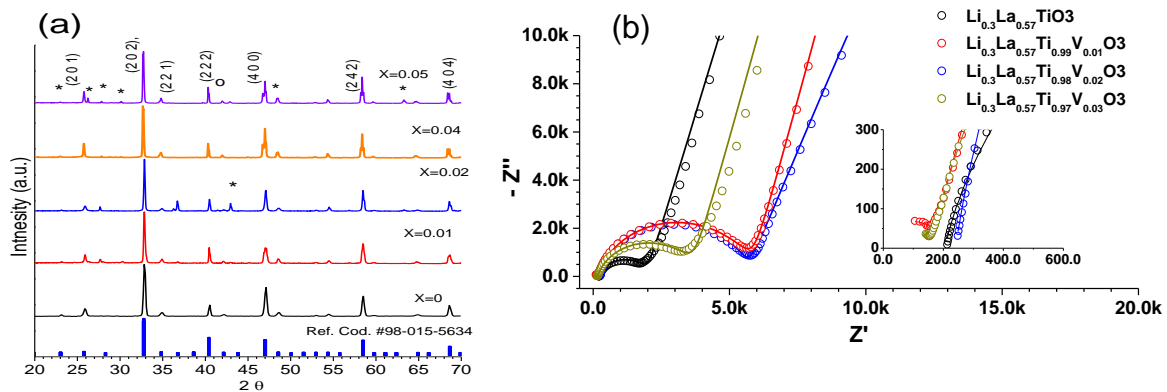
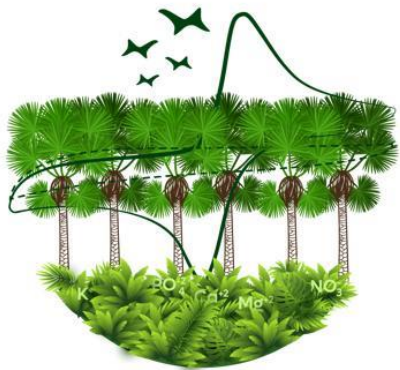


Figure 1 X-ray diffraction patterns (a) and Nyquist diagrams (b) for the V-doped  $\text{LiLaTiO}_3$  solid electrolyte.

**Keywords:** Solid electrolyte, perovskite, all-solid state battery, ionic conductivity.

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