

SYNTHESIS OF POLYMER ELECTROLYTES IMPROVED BY THE ADDITION OF LINBO₃ FOR RECHARGEABLE BATTERIES

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RESUMO

Química de Materiais (MAT) Introduction

Lithium-ion rechargeable batteries (*LIBs*) components of numerous electronic devices and energy storage systems, have drawn significant attention from researchers because of their importance in improving efficiency and safety¹. Among the vital components of lithium-ion batteries is the electrolyte, which facilitates the transportation of lithium ions between the positive and negative electrodes. This study, aims to develop an *SPE* that enhances the properties of *LIBs* by synthesizing, materials composed of lithium perchlorate (LiClO_4), polyvinyl alcohol (PVA) and polyethylene oxide (PEO), with the addition of lithium niobate (LiNbO_3). The study revealed that incorporating LiNbO_3 on the polymeric matrix increased the ionic conductivity (σ) and lithium transfer number (t_+) of the electrolytes, which are critical factors for enhancing battery performance. **Objective**

The main objective of the research is the development of polymeric solid electrolytes based on pure $\text{LiClO}_4/\text{PVA-PEO}$ and improved by the insertion of LiNbO_3 to replace conventional liquid electrolytes for use in rechargeable lithium-ion batteries. **Methods**

Originally, LiNbO_3 powders were synthesized in the laboratory from specific precursors (hydrated lithium oxalate, $\text{Li}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$, and niobium pentoxide, Nb_2O_5), calcined at 600°C . Subsequently, pure *SPE* ($A = \text{LiClO}_4/\text{PVA-PEO}$) and the *SPE* with the addition of LiNbO_3 (B) were synthesized. Using a digital caliper, the thickness was measured, and the area of the *SPE* was calculated. After a one-week curing time, the dried *SPE* was placed between two stainless steel plates (sandwich) of the same dimensions for electrochemical analyses. Electrochemical impedance spectroscopy (EIS) and chronoamperometry tests were performed using the AUTOLAB PGSTAT 128 N potentiostat, coupled with the NOVA® 2.0.1 software copyright 2016, Metrohm Autolab B.V. **Results**

The structural analysis by X-ray diffraction (XRD) revealed the rhombohedral phase of LiNbO_3 (JCPDS N° 20-631). Scanning Electron Microscopy (SEM) images showed that the material had a porous structure with a uniform distribution of LiNbO_3 clusters. The EIS results showed that the ionic

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conductivity increased by approximately 16.17% after the addition of LiNbO_3 (*SPE/B*). Additionally, the EIS results combined with chronoamperometry allowed obtaining values for current densities and charge transport resistances at the beginning (i_0 , R_{e0}) and at the end (i_{SS} , R_{eSS}). With the collected results, calculations were performed to obtain lithium transfer numbers (t_+ , $0 \leq t_+ \leq 1 \rightarrow$ for *SPE*). The results showed that $t_+ = 0.213$ for *SPE/A* and $t_+ = 0.839$ for *SPE/B*. **Conclusion**

The results confirmed the synthesis of an *SPE* that uses lithium salt, promoting an increase in ionic conductivity ($\sigma = 1.02\text{E-}03 \text{ } \Omega \text{ cm}^{-1}$) and in the lithium transfer number ($t_+ = 0.839$) at 25°C . This, demonstrates the potential of the developed *SPE*, especially after the insertion of LiNbO_3 , and indicates that it is a simple, cost-effective, and promising strategy, for improving key components of rechargeable lithium ion batteries.

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PALAVRAS-CHAVE: Ionic conductivity (σ), lithium perchlorate (LiClO_4), lithium transfer number (t_+), rechargeable LIBs, solid polymer electrolyte (SPE)

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