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SYNTHESIS OF POLYMER ELECTROLYTES IMPROVED BY THE ADDITION OF $KNbO_3$ FOR RECHARGEABLE BATTERIES

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RESUMO

Lithium-ion rechargeable batteries (LIBs), essential components of electronic devices and energy storage systems, have attracted considerable attention due to their role in improving efficiency and safety. A key component of LIBs is the electrolyte, responsible for transporting lithium ions between the positive and negative electrodes. This study aims to develop a solid polymer electrolyte (SPE) composed of lithium perchlorate ($LiClO_4$), polyvinyl alcohol (PVA), and polyethylene oxide (PEO), enhanced by the addition of potassium niobate ($KNbO_3$) to improve LIB performance. The main objective of the research is the development of polymeric solid electrolytes based on pure $LiClO_4$/PVA-PEO and improved by the insertion of $KNbO_3$, to replace conventional liquid electrolytes for use in rechargeable lithium-ion batteries. Originally, $KNbO_3$ powders were synthesized in the laboratory from specific precursors (hydrated potassium oxalate, $K_2C_2O_4{\cdot}2H_2O$, and niobium pentoxide, Nb_2O_5), calcined at 600°C. Subsequently, pure SPE (A = $LiClO_4$/PVA-PEO) and the SPE with the addition of $KNbO_3$ (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. X-ray diffraction (XRD) with Rietveld refinement identified two crystalline phases of $KNbO_3$: cubic (JCPDS No. 01-083-3855) and tetragonal (JCPDS No. 01-083-3856), with a residual profile factor (S) of 1.21 and a correlation coefficient (χ^2) of 1.45, indicating good fit. Scanning Electron Microscopy (SEM) revealed a morphology of dense $KNbO_3$ clusters with irregular sizes, uniformly distributed in the polymer matrix. Electrochemical impedance spectroscopy (EIS) showed a 38.78% increase in ionic conductivity after adding $KNbO_3$ (SPE/B) compared to pure SPE (A). Combined EIS and chronoamperometry provided current densities and charge transport

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resistances (i_0, Re_0 and iSS, ReSS), allowing calculation of lithium transfer numbers (t^+, $0 \leq t^+ \leq 1$)[1]. The t^+ increased from 0.271 (SPE/A) to 0.825 (SPE/B), while ionic conductivity (σ) reached $9.82 \times 10^{-4} \Omega \cdot cm^{-1}$ at 25°C, confirming the positive impact of $KNbO_3$ on ion mobility. These results demonstrate that $KNbO_3$-enhanced SPE offers superior lithium-ion transport and conductivity, representing a promising alternative to conventional liquid electrolytes in LIBs. [1]Deivanayagam, R.; Shahbazian-Yassar, R. *Electrochemical methods and protocols for characterization of ceramic and polymer electrolytes for rechargeable batteries*. Batteries & Supercaps**.** 2020, 4, 596–606. The results confirmed the successful synthesis of an SPE utilizing lithium salt, which promotes a considerable increase in ionic conductivity (σ = 9.82E-04 $\Omega \cdot cm^{-1}$) and lithium transfer number (t^+ = 0.825) at room temperature (25°C).These outcomes highlight the potential of the developed SPE, especially after the incorporation of $KNbO_3$, as 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 (LiClO4), lithium transfer number (t+), rechargeable LIBs, solid polymer electrolyte (SPE)

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