Tungsten Phosphate Glasses and Glass-ceramics as Conductive Solid Electrolytes

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With technology progress and the availability of more electronic devices and gadgets on market, interest in better energy storage systems has increased. Liquid electrolytes are vastly used as primary and secondary batteries. One major problem is the environment harm that can be caused by their disposal. Solid electrolytes are being studied as a replacement, even if the same values of ionic conductivity are not reached. A promisor material that can be used as an alternative is glass-ceramics.

Glass-ceramics are produced by controlled crystallization of certain glasses. Therefore, these materials combine important features of glassy and crystalline materials, such as, for example, ionic conductivity.[1] This feature is interesting since it makes possible the investigation of glass-ceramics as solid energy storage systems and, consequently, as solid secondary, or rechargeable, batteries.

As the crystallization occurs, the glass matrix shall have two structural regions: the first composed by the glass former, with covalent bonds between its atoms and the second made form transition metals, ionic or non-bridging bonds. Therefore, the ionic transport is facilitated by the modified inner regions.[2]

The present work correlates the structure and ionic conductivity of phosphate glasses and glass-ceramics. Samples with composition x WO_3 0.4 $(LiPO_3)_n$ (0.6-x) Li_2O were produced by melting quenching methodology. Chemical batches of 10 g were mixed and melted at 900-1100 °C for 1 h and annealed at respective Tg+50 °C for 3 h. Incorporation of tungsten causes a linear rise of Tg, depolymerization of P-O-P chains, producing P-O-W bonds and, after saturation, appearance of WO_6 units clusters. Samples with x=0.4 exhibited the lowest activation energy and the highest ionic conductivity at 300 K values. Which means there is an optimal value of x, $0.3<x<0.5$, for best ionic conductivity and lowest activation energy.

References:
1.Ferreira, E. B.; Za notto, E. D. Quim. Nova. **2002**, 25, 5, 731.
2.Greaves, G. N. *J. Non-Cryst. Solids*. **1985**, 71, 203.

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