INFLUENCE OF SI ADDITIVES ON THE STRUCTURE OF NANOCRYSTALLISED Na2VFe2(PO4)3ALLUAUDITE-LIKE GLASSES

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Last few decades, intensive development of batteries has been observed. Right now, they are used almost everywhere: in electric cars, smartphones, and even to stabilize power output from renewable power sources. In the last case, sodium-ion batteries (NIBs) are expected to be a sustainable and cheap alternative to lithium ones [1]. Alluaudites, first described by Fisher in 1955 [2], are among the prospective cathode materials for NIBs, with a theoretical gravimetric capacity close to 170 mAh/g [3]. However, poor electrical conductivity is one of the main obstacles to their implementation.

Previous studies on amorphous analogs of cathode materials for Li-ion batteries show a significant increase in electrical conductivity as a result of their thermal nanocrystallization due to the occurrence of the preferable conditions for the polaron hopping mechanism of conduction [5]. A similar procedure can be successfully applied to sodium compounds as well.

In our previous research, we studied materials with a nominal composition of $Na_2Fe_3(PO_4)_3$, $Na_2Fe_2V(PO_4)_3$, and $Na_2FeMnV(PO_4)_3$. Thermal treatment of glassy samples led to nanocrystallisation of the alluaudite phase [4]. We observed a significant (5 orders of magnitude) and irreversible conductivity increase, resulting in nanomaterials with $\sigma(25°C) \approx 1$ mS/cm. We also elaborated optimal synthesis conditions to obtain alluaudite-like nanomaterials with maximum possible phase purity [6]. We performed electrochemical characterisation of the most prospective samples in prototype sodium cells. Their average performance, however, did not reflect the superior electrical conductivity of the active material.

Therefore, in this work, we decided to synthesise $Na_2Fe_2V(PO_4)_3$ alluaudite-like glass with an addition of silicon oxide. It is expected that SiO_4 tetrahedra might change the ion transport in nanocrystalline materials from 1D to 2D and, consequently, improve electrochemical performance. In this work, we present thermal (DSC), structural (XRD), and electrical (IS) properties of our materials.

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