

ANALYSIS OF MANGANESE CONTENT INFLUENCE IN NASICON-STRUCTURED $\text{Na}_{2x}\text{Zr}_{2-x}\text{Mn}_x(\text{PO}_4)_3$ PREPARED VIA SOL-GEL METHOD AND ITS USE AS A CATHODE IN AQUEOUS Na-BASED BATTERIES

Gytis Baranovas¹, Jurgis Pilipavicius^{1,2}, Linas Vilciauskas^{1,2}

¹ Institute of Chemistry, Faculty of Chemistry and Geosciences, Vilnius University, Lithuania

² Department of Chemical Engineering and Technology, Institute of Chemistry, Center for Physical Sciences and Technology, Lithuania
gytisba7@gmail.com

Lithium-ion batteries have been used for decades as high-power energy storage for portable electronic devices, not to mention their usage as a substitute power source for electric motors instead of combustion engines [1]. However, as the demand for sustainable energy all around the world increases, development of batteries based on earth-abundant materials have been getting increased attention in the recent years. In the pursuit of these new batteries, Na-based energy storage systems have been investigated as the best alternative for lithium batteries due to the high-abundance of sodium in sea water and various salt deposits as well as sodium itself being the second smallest alkali element and possessing the most beneficial electrochemical properties after lithium [1, 2]. Aqueous batteries also have gained more traction due to reduced flammability and lower price in comparison to their organic electrolyte-based counterparts [3]. Throughout the research of Na-based batteries, Na^+ cathodes consisting of polyanionic transition-metal compounds with open-frameworks structures have been investigated [4]. During this investigation rhombohedral NASICON structured $\text{Na}_3\text{MnZr}(\text{PO}_4)_3$ (NMZP) has been used as a cathode material and provided electrochemical performance greater than other manganese phosphate cathodes reported in the literature up to that point [4].

The objective of this work is to investigate Mn substitution level influence to $\text{Na}_{2x}\text{Zr}_{2-x}\text{Mn}_x(\text{PO}_4)_3$ via sol-gel method as well as investigate the structure and electrochemical properties of the obtained material for use as a cathode in aqueous Na-based batteries.

Pure NASICON-structured $\text{Na}_3\text{MnZr}(\text{PO}_4)_3$ was obtained by dissolving and mixing sodium acetate and manganese acetate in water, then adding citric acid in one beaker, dissolving ammonium dihydrogen phosphate in water in another beaker, diluting zirconium acetate in water in third beaker and then mixing all the reagents together. In order to investigate the structural shift of NMZP, sols with varying amount of Zr and Mn were performed using the same synthesis method. Obtained sols then were dried into powders and heat treated under nitrogen in 750°C and characterized by x-ray diffraction (XRD). Decreasing amount of Zn and increasing amount of Mn in the structure led to the structure changing from $\text{NaZr}_2(\text{PO}_4)_3$ (NZP) to NMZP (figure 1). Scanning electron microscope (SEM) images have shown the formation of particle clusters, with particle size being about 100-200 nm (figure 2). Nevertheless, electrochemical analysis of the material is needed to be done in order to ascertain NMZP as a viable cathode material for aqueous Na-based batteries.

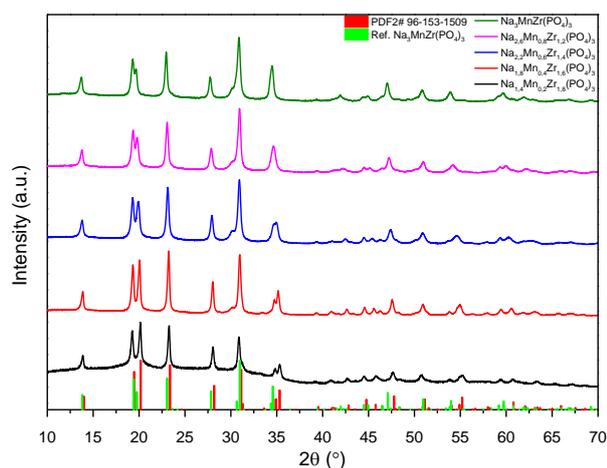


Fig. 1. XRD graph of NMZP with different amounts of Zn and Mn

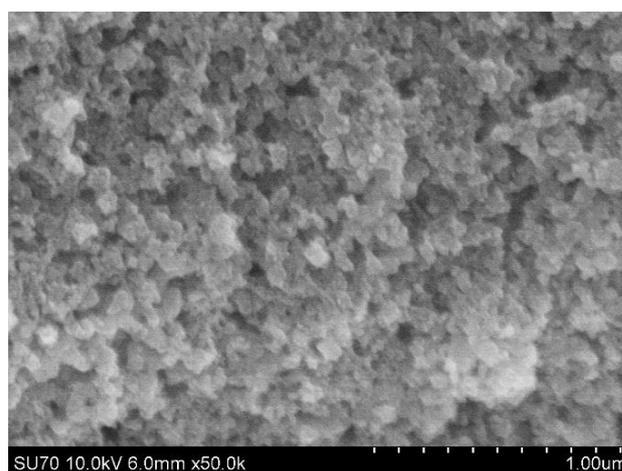


Fig. 2. SEM image of synthesized $\text{Na}_3\text{MnZr}(\text{PO}_4)_3$

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