Synthesis, structure and impedance spectroscopy of $NaCsZn_{0.5}Mn_{0.5}P_2O_7$ pyrophosphate ceramics

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Abstract

It is known that numerous compounds in the pyrophosphate family are attractive materials for applications in the sodium ion batteries [1, 2]. The evolution of Na^+ ion batteries stimulates search for new materials for such energy storage devices. In the present work new $NaCsZn_{0.5}Mn_{0.5}P_2O_7$ pyrophosphate was synthesized by solid state reaction and it was studied by X-ray diffraction (XRD) from the powder in the temperature range from room (RT) to 700 K. Rietveld analysis of XRD patterns showed that $NaCsZn_{0.5}Mn_{0.5}P_2O_7$ is a mix of three phases: (I) orthorhombic (s.g. $Cmc2_1$ [3]) $NaCsMnP_2O_7$, (II) monoclinic (s.g. $P2_1/n$) $NaCsZnP_2O_7$ and (III) monoclinic (s.g. $P2_1/n$ [4]) $Cs_2MnP_4O_{12}$. In the temperature ranges (380 – 460) K and (500 - 600) K the anomalies of lattice parameters for the (I) and (III) phases respectively were found. The anomalous behaviour of differential scanning colorimetry (DSC) in the temperature range (500 - 600) K was indicated. These anomalies can be caused by structural phase transitions in (I) and (III) phases. For the measurements of electrical properties, the ceramic samples have been sintered at 953 K temperature for 2 h in air. Electrical properties of the ceramics were investigated in the temperature interval from RT to 700 K and in the frequency range 10 - $3 \cdot 10^9$ Hz. The anomalies of electrical conductivity, dielectric permittivity and dielectric losses in the temperature ranges (380 – 460) K and (500-600) K were found in these ceramics. This phenomenon can be associated with phase transitions in the (I) and (III) phases.

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References

[1] P. Barpanda, et all., Solid State Ionics, 268 (2014) 305.
[2] John M. Clark et all., J. Mater. Chem. A, 2 (2014) 11807.
[3] Quan Huang, Shiou-Jyn Hwu, Inorg. Chem. 37 (1998) 5869.
[4] B. Klinkert, M. J. Jansen, Z. anorg. allg. Chem. 570 (1989) 102.

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