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Structural and ac conductivity studies of sodium tetralead triphosphate compound.

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Abstract

Sodium tetralead triphosphate $NaPb_4(PO_4)_3$ compound was synthesized by the solid-state reaction method, characterized through X-ray powder diffraction, Raman and electrical impedance spectroscopy. A Rietveld analysis of powder X-ray diffraction has shown that the title compound crystallizes in the hexagonal system at room temperature, space group $P6_3/m$. A pellet of 92% density was used for the electrical measurements. All electrical measurements of real and imaginary components of the impedance parameters were made over a wide range of temperature (598–720) K and frequency (209Hz to 1 MHz) using a Tegam 3550 impedance analyzer interfaced to a compatible computer. Ac conductivity data affirm that for high frequencies σ_{ac} is proportional to ω^s. The frequency exponent values increase with increasing temperature revealing that the non-overlapping small polaron tunneling is the appropriate conduction mechanism.

Keywords: $NaPb_4(PO_4)_3$, Electrical properties, Ac conductivity, NSPT model.

1. Introduction

During recent years, compounds belonging to the $AB_4(PO_4)_3$ family with apatite structure (A=alkali metal, M=divalent metal cation) have been the object of numerous investigations thanks to their biological importance [1]. They have been extensively used as biomaterials in medicine and laser luminescent materials, sensors, solid electrolytes, sorbents, catalysts [2, 3].

Lead in apatites has drawn substantial attention from two points of view. First, lead is known as a bone seeker, in that it accumulates in bones and teeth. On the other hand, it may contribute to deviation from the general formula of apatites. For this reason the series of compounds of formula $APb_4(PO_4)_3$ with (A = Na, Ag, K,Cs) became the target of several authors[4, 5]. As element of this group, the present work selected $NaPb_4(PO_4)_3$ material for investigation. Refinement of the crystal structure of $NaPb_4(PO_4)_3$ compounds showed that they crystallize in hexagonal system with space group $P6_3/m$[6,7] .For this last the