Accepted Manuscript

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Rabiaa Chtourou, Bassem Louati, Kamel Guidara

PII: S0925-8388(17)32892-X

DOI: 10.1016/j.jallcom.2017.08.163

Reference: JALCOM 42920

To appear in: *Journal of Alloys and Compounds*

Received Date: 6 June 2017

Revised Date: 9 August 2017

Accepted Date: 16 August 2017

Please cite this article as: R. Chtourou, B. Louati, K. Guidara, AC and DC conductivity study of $KPb_4(PO_4)_3$ compound using impedance spectroscopy, *Journal of Alloys and Compounds* (2017), doi: 10.1016/j.jallcom.2017.08.163.

AC and DC conductivity study of $KPb_4(PO_4)_3$ compound using impedance spectroscopy

Rabiaa Chtourou*, Bassem Louati, Kamel Guidara

Laboratory of spectroscopic characterization and optic materials, University of Sfax, Faculty of Sciences
B.P. 1171, 3000, Sfax-TUNISIA
*rab.chtourou@gmail.com

Abstract

Orthophosphate $KPb_4(PO_4)_3$ compound was synthesized by the conventional solid-state reaction . The phase formation of the compound was confirmed from the powder X-ray diffraction. Vibrational study confirms the existence of $[PO_4]^{3-}$ group. The impedance spectroscopy measurements was realized with Compact disc, Φ= 8mm diameter and 1.2 mm thickness in the range temperature (659–708)K and frequency (209Hz to 1 MHz), respectively. As well, the impedance spectra are well adjusted to an equivalent circuit formed by a serial combination of three cells. It was found that the non-overlapping small polaron tunneling (NSPT) model is suitable to describe the conduction mechanism in this compound.

Keywords: Orthophosphate, Electrical properties, Ac conductivity, NSPT model

1. Introduction

Design and discovery of new materials that can be used diverse areas of science and technology are attracted much attention as one of research issues. Many strategies and methods have been used to synthesize new compounds.

Among what materials, the compounds of the apatite type have been studied in the literature. These materials can be used for various applications, such as catalysts [1], ionic exchangers for harmful ions [2] and luminescent materials [3-5] as well as in optoelectronics [6] and bio-materials [7]. Considerably, they are also attracting attention as a new class of oxide ion conductors [8-10].Usually, the general chemical formula of this compounds is $M_{10}(YO_4)_6X_2$ this family of apatite has been crystallized in hexagonal system with space group $P6_3/m$ [11, 12]. Several authors has been are interested to demonstrate the structure of apatite .The structure is describe as follows. The YO_4 tetrahedrons are arranged around the 6_3 screw axes forming columns around the crystallographic c axis with X ions on the axis [10]. In one cell, the ten cations are distributed on two sites where six of them fill the (6h) sites making equilateral triangles and the remaining four cations occupy the (4f) sites. The coordination number is seven for the (6h) cations, six O and one X; while is nine (Oxygen atoms) for the