The Serbian Society for Ceramic Materials

Institute for Multidisciplinary Research (IMSI), University of Belgrade

Institute of Physics, University of Belgrade

Center of Excellence for the Synthesis, Processing and Characterization of Materials for use in Extreme Conditions “CEXTREME LAB” - Institute of Nuclear Sciences “Vinča”, University of Belgrade

Faculty of Mechanical Engineering, University of Belgrade

Center of Excellence for Green Technologies, Institute for Multidisciplinary Research, University of Belgrade

Faculty of Technology and Metallurgy, University of Belgrade

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6CSCS-2022

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Branko Matović
Aleksandra Dapčević
Vladimir V. Srdić

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THE DEFECT STRUCTURE AND ELECTRICAL PROPERTIES OF THE SPARK PLASMA SINTERED ANTIMONY-DOPED BARIUM STANNATE

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Barium stannate, $BaSnO_3$ (BSO), is a perovskite-type alkaline earth metal stannate with almost ideal cubic structure. Appropriate doping can alter this wide band gap material's electrical characteristics and change it either into a proton conductor or n-type semiconductor. In the case of Sb doping on Sn site, BSO becomes n-type semiconductor with high electrical conductivity at 25 °C.

The major drawback of BSO-based ceramics is its low density. The conventional solid state procedure requires long thermal treatments with several intermittent grinding and heating steps at temperatures up to 1600 °C [1].

To overcome this problem, we used Spark Plasma Sintering technique (SPS) for the preparation of $BaSn_{1-x}Sb_xO_3$, (x = 0.00 (BSSO0) and 0.08 (BSSO8)) ceramic samples. The samples structural properties were investigated using XRD (X-Ray Powder Diffraction), XPS (X-Ray Photoelectron Spectrophotmetry) and SIMS (Secondary Ion Mass Spectrometry) analyses. XPS analysis revealed the existence of many structural defects, including mixed oxidation states of tin (Sn^{2+}/Sn^{4+}) and oxygen vacancies (V_O) in both BSSO samples.

The electrical properties of the BSSO ceramic samples were investigated in the temperature range of 4–300 K. The presence of oxygen vacancies in the BSSO0 sample led to the absence of the standard activated semiconductor behavior, showing almost linear temperature-dependent resistivity in the examined temperature range. On the other hand, the BSSO8 sample showed almost temperature-independent resistivity in the range of 70–300 K. This could be a consequence of the presence of many structural defects such as mixed oxidation states of Sn^{2+}/Sn^{4+}, probably Sb^{3+}/Sb^{5+} and significant amount of O^- species, as well as the presence of the low angle grain boundaries found in this sample. The BSSO8 ceramic sample could satisfy the huge demand for the linear resistors with moderate and high conductivity, due to its low and almost constant electrical resistivity in the wide temperature.

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THE COMPARISON OF ELECTROCHEMICAL PROPERTIES OF $ZnMn_2O_4$ AND $ZnCr_{0.15}Mn_{1.85}O_4$ IN AN AQUEOUS SOLUTION OF $ZnCl_2$

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As commercial Li-ion batteries are chiefly composed of a toxic and flammable electrolyte, as well as that Li itself is also toxic and not economical for widespread use due to its rare metal nature, the aim of this work is to create an aqueous Zn-ion battery that contains the same cathode material as used in Li-ion batteries. The materials $ZnMn_2O_4$ and $ZnCr_{0.15}Mn_{1.85}O_4$ were synthesized through glycine nitrate combustion. The initial material $ZnMn_2O_4$ was doped with Cr^{3+} in order to diminish Jan-Teller distortion which prevents of Zn^{2+} ions to fully intercalate into their original sites of crystal lattice. The materials were characterized by X-ray powder diffraction (XRPD) and scanning electron microscopy (SEM), while the electrochemical properties were examined through cyclic voltammetry in aqueous solutions of $ZnCl_2$. The capacities obtained for the cyclic voltamogrammes recorded at 10 mVs^{-1} and 50 mVs^{-1} showed that cathode capacities for $ZnMn_2O_4$ amounted to be 12.4 $mAhg^{-1}$ for 10 mVs^{-1}, as well as 4.8 $mAhg^{-1}$ for 50 mVs^{-1}. The $ZnCr_{0.15}Mn_{1.85}O_4$ demonstrated 45.3 $mAhg^{-1}$ for 10 mVs^{-1}, as well as 12.6 $mAhg^{-1}$ for 50 mVs^{-1}. The results obtained for the capacities of the original and doped material indicate that doping with Cr^{2+} partly diminishes the Jan Teller effect and facilitates the intercalation of Zn^{2+} ions.