# Electrical properties of $Sr_2InV_3O_{11}$

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The last few decades, intensification has been observed in the field of research on multicomponent oxide systems, which is frequently aimed at obtaining new materials of interesting electric, magnetic or catalytic properties. Investigations dealing with systems based on the oxides of divalent and trivalent metals have allowed among others to prove an existence of a series of compounds with the general formula $A_2BV_3O_{11}$ (where: A(II) and B(III)- metals), *e.g.* $Zn_2FeV_3O_{11}$, $Mg_2CrV_3O_{11}$, $Ni_2FeV_3O_{11}$ $Pb_2BiV_3O_{11}$, $Sr_2BiV_3O_{11}$. It can be concluded from bibliographic data that these compounds are likely to find an application for example as cathode materials in high-energy cells or as components of effective catalysts for the oxidation processes of light hydrocarbons.

The investigations of reactions occurring in the $SrO–V_2O_5–In_2O_3$ system have permitted a statement that also in this system a new compound on the formula $Sr_2InV_3O_{11}$ is formed [1–3]. Hitherto performed works have shown, that a synthesis of $Sr_2InV_3O_{11}$ can be conducted by heating the mixture of $SrCO_3$ /$In_2O_3$/$V_2O_5$ (in molar ratio 4:1:3) in the atmosphere of air in the temperature range 450-800°C [1,2]. The unit cell of such obtained $Sr_2InV_3O_{11}$ has been found to be monoclinic with the following parameters: $a$ = 0.9671(3) nm, $b$ = 1.9509(8) nm, $c$ = 0.6570(2) nm, $\beta$ = 96.60(3)°, $V$ = 1.2313 nm$^3$. The experimental density of $Sr_2InV_3O_{11}$ is equal to 4.39 ± 0.05 g/cm$^3$ [3]. The energy gap calculated from the UV-vis measurements gave $E_g$ = 3.5 eV.

The electrical conductivity $\sigma(T)$ and the *I-V* characteristics have been measured with the aid of the DC method in the temperature range 300–400 K using a KEITHLEY 6517B Electrometer/High Resistance Meter. The thermoelectric power *S(T)* was measured in the temperature range 300–600 K with the aid of a Seebeck Effect Measurement System (MMR Technologies, Inc., USA). Broadband dielectric spectroscopy measurements were carried out using pellet, polished and sputtered with (~80 nm) Ag electrodes in the frequency range from $5\times10^2$ to $1\times10^6$ Hz with a Novocontrol Alpha Impedance Analyser and in the temperature range 76–400 K. The sample electrode surface and thickness were 5 mm$^2$ and 1.0 mm, respectively. For measuring $\varepsilon_r = C/C_0$, where $C_0$ is the capacity of the empty capacitor and $\tan\delta = \varepsilon''/\varepsilon'$, where $\varepsilon''$ and $\varepsilon'$ are imaginary and real part of complex dielectric permittivity, respectively.

The *p*-type electrical conductivity below $\sigma = 3.4\cdot10^{-9}$ S/m in the temperature range 300-400 K was observed. Such small values of $\sigma$ are typical for insulators and correlate well with the value of the energy gap *E*g = 3.5 eV [3]. Moreover, in the temperature range 350-400 K a strong increase of $\sigma$ with the activation energy $E_A$ = 0.79 eV of the Arrhenius-type characteristic for semiconducting state appeared. Above 400 K only *n*-type thermoelectric power was observed.

[1] E. Filipek, A. Pacześna, Polish Patent No. P404202, Warsaw, 2015.
[2] A. Pacześna, E. Filipek, *2nd Central and Eastern European Conference on Thermal Analysis and Calorimetry*, 27-30 August, 2013, Lithuania, Book of Abstracts, Vilnius, p. 306.
[3] E. Filipek, A. Pacześna, M. Piz, *Ceram. Int.*, (2016), in press.