Effect of magnesium substitution on dielectric constant of $Zn_{2-x}Mg_xInV_3O_{11}$ (x = 0.0, 0.4, 1.0, 1.6, 2.0) solid solutions

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According to literature [1–6] in the system MO–Fe_2O_3/In_2O_3–V_2O_5, where M = Mg, Zn, Co, Ni, Pb, Ba, Sr double vanadates of the general formula $M^{II}{}_2M^{III}V_3O_{11}$, *i.e.* $M_2FeV_3O_{11}$ (M = Mg, Zn, Co, Ni, Pb) and $M_2InV_3O_{11}$ (M = Mg, Zn, Co, Pb, Ba, Sr) are formed. The compounds are good candidate, which can be used for example as components of effective catalysts for the oxidation processes of light hydrocarbons or as cathode materials in high-energy cells.

Research conducted in the ternary oxide system ZnO–MgO–In_2O_3–V_2O_5 have revealed that a new solid solution of the formula $Zn_{2-x}Mg_xInV_3O_{11}$ is formed in the whole concentration range of $Zn_2InV_3O_{11}$–$Mg_2InV_3O_{11}$ subsystem [6]. The solid solution crystallizes in the triclinic system; it unite cell parameters a and b increase with increasing of Mg^{2+} ions incorporation into the crystal lattice of $Zn_2InV_3O_{11}$ while the values of the unite cell parameter c decrease with increasing magnesium content. The electrical conductivity was measured by the DC method using a KEITHLEY 6517B Electrometer/High Resistance Meter. Broadband dielectric spectroscopy measurements were carried out using pellets, polished and sputtered with (~80 nm) Ag electrodes in the frequency range from 200 Hz to 2 MHz with a Novocontrol Alpha Impedance Analyzer and in the temperature range 76–400 K.

The solid solutions of $Zn_{2-x}Mg_xInV_3O_{11}$ (x = 0.0, 0.4, 1.0, 1.6, 2.0) are semiconductors with the activation energy of 0.2-0.3 eV in the temperature range of 250-400 K. Broadband dielectric spectroscopy measurements showed a strong dependence on temperature and frequency both dielectric constant, ε_r, and loss tangent, tanδ, above 200 K. The values of ε_r and tanδ decreased strongly with increasing frequency regardless of the magnesium content in the sample. The most interesting result of these studies is the observation of an increase in the dielectric constant with an increase in the content of magnesium ions from $\varepsilon_r = 90$ for $x = 0.0$ to $\varepsilon_r = 450$ for $x = 2.0$ at 400 K. Such behaviour could be considered as a relaxation process like with Maxwell-Wagner [7] or Jonscher [8], which is strongly obscured by dc conductivity as well as oxidizing and passive properties of magnesium ions contributing to increased accumulation of electric charge. Similar behavior was found in $Cu_2In_3VO_9$ ceramics [9].

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