Electrical properties of $CuInVO_5$

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$CuInVO_5$ has been synthesised by heating the alloy of CuInV in pure oxygen atmosphere at 650°C for 48 hours. It crystallises in monoclinic system and its elementary cell parameters are: a = 0.8793 (2) nm, b = 0.61542(6) nm c = 1.5262(2) nm, β = 106.69(2)º, Z = 4 [1]. The structure of $CuInVO_5$ contains isolated Cu_4O_{18} – groups consisting of trans edge sharing CuO_6 – octahedral. Interconnection of the groups by $[In_4O_{16}]$ – ribbons running along [010] which are built of edge- and corner-sharing InO_6 – octahedral results in the formation of slabs perpendicular to the c-axis. VO_4^{3-} groups link the slabs to a three-dimensional framework. The structure may be derived from a cubic closet packing of the oxygen atoms with copper and indium atoms in the octahedral and vanadium atoms in the tetrahedral vacancies. In our study the compound $CuInVO_5$ as a pure phase has been obtained from the mixture of oxides V_2O_5, CuO and In_2O_3 used at the molar ratio 1 : 2 : 1 and from equimolar mixture of CuO and $InVO_4$ [2]. From IR spectroscopic studies it shows that $CuInVO_5$ is built with CuO_6, InO_6 octahedra and VO_4 tetrahedra [2].

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 5×10^2 to 1×10^6 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 ε'' and ε' are imaginary and real part of complex dielectric permittivity, respectively.

The electrical conductivity of the Arrhenius-type characteristic for semiconductors with the activation energy E_A = 0.42 eV in the temperature range 300-400 K was observed. The temperature dependence of thermopower, *S(T)*, showed *n-p* transition at 465 K. The most interesting observation concerns the symmetric and linear characteristics *I-V* both at 300 and 400 K, showing a strong increase in electron emission and conductance by two orders of magnitude. A large carrier emission of the Arrhenius type observed in $CuInVO_5$ one can explain with the help of the Poole–Frenkel effect, because the electrons of copper ions on the unfilled 3*d* orbital are unscreened. For this reason, this compound can easily be polarized under the influence of an applied external electric field. The dielectric measurements showed non-linear and strong increase of the relative dielectric permittivity ε_r with increasing temperature above 200 K and its strong decrease with increasing frequency. Similar behavior has been observed for the loss tangent.

References

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