Dielectric properties of $RE_2W_2O_9$ (RE = Pr, Sm-Gd)

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Tungstates, molybdates and molybdato-tungstates doped with rare-earth ions are promising materials to use as phosphors in LEDs and as ultra-short solid state lasers [1,2]. The compounds under study crystallize in the monoclinic type structure with the space group *P*21/*c* [2]. Magnetic susceptibility measurements showed a paramagnetic state of magnetic moments above 4.2 K for $RE_2W_2O_9$ compounds (RE = Pr, Nd and Gd), and a weak response to the magnetic field and the temperature for $Sm_2W_2O_9$ and $Eu_2W_2O_9$ tungstates. Only for $Gd_2W_2O_9$ the magnetization is a universal function of $\mu_0 H/T$, characteristic for the superparamagnetism [3].

The electrical conductivity σ(T) and the *I-V* characteristics of the tungstates under study have been measured with the aid of the DC method using a KEITHLEY 6517B Electrometer/High Resistance Meter. The thermoelectric power *S*(T) was measured in the temperature range of 300-600 K with the aid of a Seebeck Effect Measurement System (MMR Technologies, Inc., USA). Dielectric measurements were carried out using pellets, polished and sputtered with (~80 nm) Ag electrodes in a frequency range from $5\cdot10^2$ to $5\cdot10^6$ Hz on a Novocontrol Alpha Impedance analyzer. For the electrical measurements, the powder samples were compacted in a disc form (10 mm in diameter and 1–2 mm thick) using a pressure of 1.5 GPa and then they were sintered during 2 h at 1073 K.

The σ(T) and *S*(T) measurements showed the insulating properties and a weak conduction of *n*-type for $Sm_2W_2O_9$ and $Eu_2W_2O_9$ as well as *p*-type one for $Pr_2W_2O_9$ and $Gd_2W_2O_9$. The *I-V* characteristics of $RE_2W_2O_9$ tungstates (RE = Pr, Sm-Gd), measured at 300 and 400 K, showed symmetrical and linear behavior as well as almost a permanent conductance which is slightly higher at higher temperature. Relative dielectric permittivity (ε_r), real (ε') and imaginary (ε'') components of permittivity as well as loss tangent ($\tan\delta$) do not depend on the temperature for all tungstates under study. ε_r and ε' increase from 8 via 12 and 17 to 32 in the sequence of the RE element: Gd, Eu, Pr and Sm, respectively. Loss tangent is close to zero for all samples. ε_r, ε' and ε'' show a maximum at the frequency $f = 2\cdot10^6$ Hz, characteristic of dipole polarization. These results are interpreted in the context of the shallow trap levels [4] and Maxwell-Wagner model [5]. Thus, in the examined ceramics may form the boundary phases and insulating areas "immersed" in almost not-conducting solid material. It can finally lead to the accumulation of induced charge or to the blocking of the current cross-section by the boundary phases under the influence of the applied electric external field [6]. Most of the (charged) traps do reside in the grain boundaries with the depletion layers reaching into the adjacent grains.

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