I-V characteristics in $RE_2W_2O_9$ (RE = Pr, Sm-Gd)

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Doped and undoped rare-earth metal molybdates and tungstates are host candidates for luminescent and laser applications. They are used for a fabrication of white light-emitting diodes showing high stability, energy-saving and safety [1,2]. Magnetic susceptibility measurements revealed a disordered state of magnetic moments above 4.2 K for all $RE_2W_2O_9$ compounds (RE = Pr, Nd and Gd), a weak response to the magnetic field and the temperature for $Sm_2W_2O_9$ and $Eu_2W_2O_9$ tungstates. The temperature independent component of magnetic susceptibility has a positive value for $RE_2W_2O_9$ (RE = Pr, Nd and Gd) indicating a domination of van Vleck contribution. Only for $Gd_2W_2O_9$ the magnetization is a universal function of $\mu_0 H/T$, characteristic for the superparamagnetism [3].

The electrical resistivity ρ(T) and the *I-V* characteristics of 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). 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 ρ(T) and *S*(T) measurements showed the insulating properties and *n*-type conduction for $Sm_2W_2O_9$ and $Eu_2W_2O_9$ as well as *p*-type one for $Pr_2W_2O_9$, and for $Gd_2W_2O_9$. The *I-V* characteristics of $RE_2W_2O_9$ tungstates (RE = Pr, Nd and Gd), measured at 300 and 400 K, showed the non-symmetric and linear behaviour as well as a slight decrease of the conductance *G vs*. the applied voltage *V*. Such behaviour may correspond to an energy dissipation. It means that the majority charge carriers are probably partially absorbed by the shallow trapping centres [4] lying under the bottom of the conduction band. Another explanation is that the examined ceramics may create boundary phases and insulating areas "immersed" in almost not-conducting solid material which can well to be described with the help of a double array model of the condenser called the Maxwell-Wagner model [5]. 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. A similar behaviour was observed in some varistors (*e.g.* ZnO) [7], and in other ceramic materials (*e.g.* Nb_2VSbO_{10}) [8].

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