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Electrical properties of $PbWO_4$ single crystal

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The ion-electron processes in undoped $PbWO_4$ single crystal at the transition to quasi-equilibrium state in a constant external electric field with linearly changing temperature in 290 to 600 K range as well as in isothermal conditions have been studied by methods of electric conductivity, thermally stimulated polarization current and thermally stimulated depolarization one. The experimental temperature dependence of conductivity is supposed to be describable it terms of small polaron theory. Thermally stimulated polarization/depolarization currents are interpreted using the space-charge mechanism of the spatially unhomogeneous charge distribution in the sample (current peaks in the 400 to 550 K range) and dipole one (peaks in the 290 to 370 K range). The main contribution to dipole polarization is supposed to be due to dipolons, i. e., couples of electrostatically interacting two-charge vacancies (cationic+anionic).

Ионно-электронные процессы в нелегированном монокристалле $PbWO_4$ при переходе в квазиравновесное состояние во внешнем постоянном электрическом поле при изменении температуры в пределах 290–600 К по линейному закону со временем или в изотермических условиях изучены методами электропроводности, токов термостимулированной поляризации и термостимулированной деполяризации. Предполагается, что температурную зависимость проводимости можно описать в рамках теории поляронов малого радиуса. Термостимулированные токи поляризации-деполяризации интерпретируются с привлечением объемно-зарядового (пики тока в области 400–550 К) и дипольного (пики тока в области 290–370 К) механизмов образования пространственно неоднородного распределения заряда в образце. Сделано предположение, что основной вклад в дипольную поляризацию дают диполоны — пары двухзарядных вакансий (катионная+анионная), обьединенные электростатическим взаимодействием.

Now, $PbWO_4$ (PWO) crystals are under intense studies in connection with their use, especially as self-activated, short-afterglow scintillation material [1, 2]. In spite of numerous publications aimed at PWO study, its electrophysical properties are still insufficiently known.

In [3–7] dealing with electric conductivity of PWO crystals, only incomplete data are presented obtained by measurements made in variable and constant fields under heating up to 1200 K. The conductivity of undoped PWO crystals as-grown by Czochralski technique and those annealed in vacuum and in air was studied in [8, 9] in temperature range of 120 to 350 K. Our previous results of PWO studies have been published in [10].

The nature of predominating electrically active defects in PWO is not elucidated unambiguously. Electrophysical investigation of that compound are still at its initial stage. In this work, we have studied the total electric conductivity, σ, of undoped PWO crystal as well as its thermally stimulated depolarization (TSD) and thermally stimulated polarization (TSP) currents to elucidate the regularities of ion-electron processes therein, especially, the behavior of electrically active defects of its crystal lattice at the transition to quasi-equilibrium state under linear temperature T variation in time.