The Influence of Europium Impurity on the Recombination Luminescence in Y_2O_3

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Europium as doping impurity for X-ray and cathodoluminophors is mainly interest due to its spectral features of the luminescence, property to change its valence and easily capture electrons and holes. It was revealed in [1–3] works, that F-type centers appear in monocrystals on the base of yttrium oxide after X-ray and ultraviolet light irradiations at the temperature of liquid nitrogen. F-type centers spectra are easily discolored by optic lighting from 1 μm region and thermally.

In this paper we have done the comparative study and have analyzed the spectra of X-ray luminescence (XRL) and the curves of thermostimulated luminescence (TSL) of Y_2O_3 and Y_2O_3:Eu^{3+} ceramics at X-ray excitation in 85–295 K range for the obtaining of additional information about the influence of Eu^{3+} ions on the features of recombination processes in Y_2O_3. At 85 K XRL spectrum of Y_2O_3 ceramic characterizes by wide nonelementary 3.19 eV band. Heating of Y_2O_3 sample from 85 to 210 K leads to insignificant increase of XRL intensity in spectrum maximum and from 210 to 295 K causes the sharply monotonically decrease to ~0.15 numeric value of maximum intensity. XRL spectrum of undoped ceramic at 85 K is fitted into elementary Gaussian shape bands with maxima near 3.40, 3.06, 2.67, 2.33, 2.09 and 1.91 eV considering the features of Y_2O_3 crystallization [4] and possibility of formation of short lifetime and stable hole and electron centers of V- and F-type [1–3] by ionizing radiation. 3.40 and 3.06 eV main bands of XRL are caused by self-trapped excitons of $(YO)^{9-}$ complex when the cation is localized in the field of trigonal (C_{3i}) and monoclinic (C_2) symmetries. Emission at 2.67 eV and weak bands in 1.65–2.61 eV region are considered as radiation of localized excitons on anion vacancies and electron centers of F-type (F^+, F and F^-). Doping of material by europium ions leads to appearance of Eu^{3+} centers luminescence. Eu^{3+} ions form the emission centers with C_2 symmetry in Y_2O_3:Eu^{3+}. Weak bands observed in XRL and TSL spectra are caused by $^5D_0 \rightarrow {}^7F_j$ electronic transitions in Eu^{3+}. 2.03 eV main band is associated with $^5D_0 \rightarrow {}^7F_2$ transition. It is suggested, the energy comes to Eu^{3+} ions through ($Eu^{2+}O^-$) complexes at both X-ray quanta and optical excitations of Y_2O_3:Eu^{3+} in a charge transfer band.

At 85 K three groups of peaks with different intensity in 85–140, 140–230 and 230–280 K ranges are observed in TSL curve after X-ray excitation of Y_2O_3. TSL in 185 and 203 K main peaks range is connected with thermal destruction of self-trapped states of O^- ions that located in the field of trigonal and monoclinic symmetries. Doping of Y_2O_3 by europium impurity leads to change of TSL peaks intensity ratio in 140–230 K range for 179 K peak and more effective detection of peaks in 230–280 K range. On the base of obtained results of TSL study the main parameters of capture centers of charge carriers in Y_2O_3:Eu^{3+} have been calculated.

[1] V.S. Vayner, A.I. Veynger, Yu.A. Polonskyy, Investigation of F-centers in Y_2O_3 by ESR method, *Physics of the Solid State* **18**(2) (1976) 409–412.

[2] V.S. Vayner, A.I. Veynger, Investigation of formation and transformation of point defects in Y_2O_3 monocrystals, *Physics of the Solid State* **19**(2) (1977) 528–532.

[3] V.S. Vayner, T.M. Bragina, A.I. Veynger, Yu.A. Polonskyy, Direct observation of change of the carge state sign of F-centers in Y_2O_3, *Physics of the Solid State* **21**(9) (1979) 2818–2820.

[4] F. Hanic, M. Hartmanova, S. Bagejasarov et al., Real structure of undoped Y_2O_3 single crystal, *Acta Crystallogr. Sect. B* **40**(2) (1984) 76–82.