On the Luminescence of Europium Orthotantalate

Physics

1966

SovietRxiv

Abstract

Full Text

UDC 546.651 + 546.883:535.370

Physics

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On the Luminescence of Europium Orthotantalate

(Presented by Academician N. V. Belov, December 31, 1965)

Recently, interest in the luminescent properties of various rare-earth compounds has increased sharply in connection with the prospects for their use in lasers. Compounds containing europium as an activator are being studied most intensively ($^{1-5}$). Ropp (^{1}) studied luminescence in the system La_2O_3–Gd_2O_3 –Y_2O_3 with the addition of 2.5 mol.% europium relative to the total amount of cations. Briksner ($^{2-4}$) studied rare-earth orthotantalates, aluminates, vanadates, molybdates, and tungstates activated by rare-earth elements, especially europium, with the aim of using them as laser matrices. Most of these compounds were obtained as single crystals, from which solid-state lasers were made. Europium compounds are also suitable for liquid lasers ($^{6-7}$).

It is interesting to note that the most intense luminescence of europium-activated matrices is observed at a definite activator concentration, which differs sharply for different compounds (8 mol.% in $GdVO_4$; 30 mol.% in $CaMoO_4$; 40 mol.% in $Gd_2(WO_4)_3$ (^{2})). A higher activator content leads to weakening of the luminescence.

Europium orthotantalate (^{3}) was used as an activator in $CaMoO_4$ and $CaWO_4$ matrices; its optimal concentration was 0.5 and 10 mol.%, respectively. The most intense line in the luminescence spectrum was 610 mμ. At 300 and 77° K an insignificant difference was found in the luminescence spectrum, in the intensities of the lines, and in the widths of the bands.

The task of the present work was to study the intrinsic luminescence of europium orthotantalate without additions and the luminescence of lanthanum orthotantalate. The powdered $EuTaO_4$ and $LaTaO_4$ required for the work were synthesized by the method of (^{8}). The analytically determined impurity content in $LaTaO_4$ was: Ce 0.01%, Nd and Pr less than 0.005%, Eu–0.01%; in $EuTaO_4$: Cd, Sm, Nd–each less than 0.03%. The luminescence of the compounds studied was excited by ultraviolet light with wavelength $\lambda = 265$ mμ, isolated by means of an SF-4 spectrophotometer from the complete spectrum of an SVD-120 mercury lamp. The luminescence spectrum was analyzed with a UM-2 monochromator, an FEU-14B photomultiplier having good sensitivity in

Fig. 1. Luminescence spectrum of EuTaO4 (1) and LaTaO4 (2)

Figure 1: Fig. 1. Luminescence spectrum of EuTaO4 (1) and LaTaO4 (2)

Fig. 2. Spectral distribution of excitation density of EuTaO4 (for the 608 mμ line)

Figure 2: Fig. 2. Spectral distribution of excitation density of EuTaO4 (for the 608 mμ line)

the red region of the spectrum, and an EMU-3 amplifier. The absence of scattered light from the SF-4 was checked using magnesium oxide. To measure the intensity of the exciting light, fluorescein was used, which has a constant quantum yield of luminescence in the excitation region studied. The investigations were carried out at a temperature of 300° K.

The spectrum of $EuTaO_4$ (Fig. 1, 1) contains the strongest line at 608 mμ with a half-width of 22 mμ, as well as lines at 595, 695, 656, and 538 mμ (in decreasing order of intensity). It is known that pure lanthanum compounds do not exhibit luminescence. As can be seen from Fig. 1, 2, $LaTaO_4$ possesses appreciable luminescence in the spectral region studied. The presence in the spectrum of the lines 608, 538, and 695 mμ indicates sufficiently intense luminescence of europium present at a concentration of 0.01% in the $LaTaO_4$ matrix.

The absence of a suitable excitation source with wavelength less than 220 mμ did not allow the maximum to be revealed in the excitation spectrum of $EuTaO_4$ (Fig. 2), which is apparently located in the region \$ 200–210m \$. The quantum yield η of the luminescence of $EuTaO_4$ was estimated by means of

compared with the luminescence yield of a CsJ—Tl single crystal for $\lambda_{\text{v}} = 265$ mμ. From the luminescence excitation curve (Fig. 2), η was recalculated for $\lambda_{\text{v}} = 225$ mμ and amounted to 20% of the luminescence yield of CsJ—Tl upon excitation of the latter by light with $\lambda_{\text{v}} = 265$ mμ (9). It is obvious that at the maximum of excitation of the luminescence of $EuTaO_4$ the luminescence yield of the latter will be considerably higher and, judging from the character of the excitation, may be close to 1. For $LaTaO_4$, along the 608 mμ line, η is approximately 2 times lower.

Fig. 1. Luminescence spectrum of $EuTaO_4$ (1) and $LaTaO_4$ (2)

Fig. 2. Spectral distribution of the excitation density of $EuTaO_4$ (for the 608 mμ line)

Thus, the luminescent properties of $EuTaO_4$ appear especially valuable in combination with its chemical and thermal stability (8), which is superior to that of the corresponding orthovanadates (2).

In conclusion, the authors express their deep gratitude to Corresponding Member of the Academy of Sciences of the USSR G. B. Bokii for his attention to the work.

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Received
25 XII 1965

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Note: Figure translations are in progress. See original paper for figures.