Spectroscopic Characteristics of Er^{3+} Ions in Glassy $Li_2B_4O_7$

Danyliuk P.S.[1], Rizak V.M.[1], Krasylynec V.M.[2], Birov M.M.[2], Chychura I.I.[2], Turok I.I.[2], Puga P.P.[2]

[1] *Uzhhorod National University, Uzhhorod, Ukraine*
[2] *Institute of Electron Physics, National Academy of Sciences of Ukraine, Uzhhorod, Ukraine*

The X-ray luminescence (XRL) spectra for different concentrations of Er_2O_3 in the glassy lithium tetraborate have been studied in the range of 200–800 nm. The spectra were excited using a BSV-21 X-ray tube with cobalt anticathode at 30 kV voltage and 15 mA current, and studied at room temperature using an automated complex based on an MDR-23 monochromator. As a detector, we used an FEU-106 photomultiplier. The experimental data at the FEU exit were recorded using a computer program controlling the necessary number of photon counts in each point of the studied spectral range and the spectral scan step with subsequent result processing.

The analysis of obtained dependencies $I_{XRL} = f(\lambda)$ shows that increasing Er_2O_3 concentration within the range of 0.0005–0.015 has no significant effect on XRL spectrum structure or the intensity of emission bands in the whole studied range. At dopant concentration of 0.01 mol. % the effect of concentration quenching is observed, caused by change of charge compensation, occurrence of vacancies of interstitial ions, and local symmetry change of Er^{3+} ion. These changes cause intensity redistribution and inhomogeneous line broadening without considerably shifting the centers of gravity of individual multiplets. At the maximum Er_2O_3 concentration (0.05 mol. %) the structure of the spectrum changes significantly.

The XRL spectra were interpreted in accordance with the data on energy position of levels in free Er^{3+} ion that forms an active optical center in $Li_2B_4O_7$ matrix. In general there were 36 maxima detected in the dependency $I_{XRL} = f(\lambda)$, of which we could identify 18. All identified maxima are determined by parity-forbidden intraconfigurational radiative transitions within 4f configuration of Er^{3+} ion from the excited levels of higher-lying multiplets ^2K_J ($\mathbf{J}$ = 13/2, 15/2), ^4F_J ($\mathbf{J}$ = 3/2, 5/2, 7/2, 9/2), and ^4S_J ($\mathbf{J}$ = 3/2), onto the ground level $^4I_{15/2}$. It is shown that for most of the transitions there is violation of strict selection rules for total angular momentum ($\Delta\mathbf{J} > 1$), and also for spin ($\Delta\mathbf{S} > 0$) and orbital momentum ($\Delta\mathbf{L} > 1$) in LS coupling approximation, caused by the internal field of the matrix having effect on triple-charged erbium ions via non-centrosymmetric interaction, which leads to different parity states being mixed, resulting in removing the prohibition of parity and total orbital momentum selection rules, which are strictly obeyed in the spectra of free Er^{3+} ions. The unidentified maxima might be determined either by transitions from excited states onto the ground level $^4I_{15/2}$, or by transitions between excited states.