THERMOLUMINESCENCE STUDIES OF UNDOPED LiF CRYSTALS. 2. THE OSCILLATOR-LIKE REGULARITY IN TRAP ACTIVATION ENERGIES

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S u m m a r y

The spectrum of activation energy of traps in undoped LiF crystals has been studied in detail by the method of thermoluminescence (TL) in the temperature range 80—500 K. The parameters of traps which are responsible for an intense complicated TL peak at 141 K have been studied in Part I. In this part, the energy spectrum of traps responsible for TL peaks in a higher-temperature range 150—450 K has been studied using the method of fractional curves. The activation energies of traps were found to form an oscillator-like series $E_n = \hbar\omega_{\rm TL} n$, with $\hbar\omega_{\rm TL} = 0.1617$ eV (1304 cm^{-1}). However, contrary to other crystals studied earlier, n can be both integer and half-integer. A possible origin of this regularity has been proposed. Basing upon the estimation of the statistical sum of oscillator states, a conclusion has been drawn that TL in LiF occurs through the tunneling of charge carriers from the excited vibration levels of traps to the excited states of luminescence centers. In this case, the trap activation energy is a multiple to the number of vibration quanta. But if the band mechanism is responsible for delivering a charge to the recombination center, the activation energy is described by the noticed oscillator formula with half-integer n's. This situation takes place in the case of destroying V_k-centers in LiF, as well as in all crystals studied by us earlier. Contrary to the Raman spectra of other crystals with complex lattices which were studied by us earlier, the corresponding Raman line $\hbar\omega_{\rm RS} = \hbar\omega_{\rm TL}$ was found neither in the LiF spectra nor in the spectra of other alkali halides (NaCl and KCl). Basing upon the correlation between the values of $\hbar\omega_{\rm TL}$ in LiF, NaCl, and KCl and the corresponding anion masses, we have suggested that this frequency corresponds to a local vibration mode of the halide molecule X_2^-.