Effect of optical vibrations on thermoluminescence of polysilane films and nanocomposites

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A comparative study of low-temperature (5–120 K) thermoluminescence of silicon organic polymer poly(di-n-hexylsilane) within the linear and fractional heating regimes is carried out. Polymer films, nanocomposites with the polymer introduced into the nanopores of silica matrices with the pore diameter of 2.8 nm and 10 nm, as well as dilute polymer solutions (10^{-5} mol/l) are investigated. It is found that the maxima and half-widths of the thermoluminescence curves of nanocomposites significantly depend on the diameter of silica nanopores, which is consistent with the data from the study of the polymer solutions. Based on the data on the thermoluminescence of nanocomposites with different pore diameters, the possibility to controllably change the number of charge carrier traps and their energy distribution is established. It is determined that the energy spectrum of traps in the films and nanocomposites has discrete character, and the activation energies coincide with the energy of vibrational quanta found from the Raman spectra of the polymer. This indicates that charge carriers release from the traps occurs when a charge carrier absorbs a single quantum of optical vibration [1]. For the polymer film, it is found that there are six trap activation energies that coincide with the photon energy of both symmetric and deformational optical vibrations of the polymer chain (0.011, 0.018, 0.026, 0.032, 0.042, 0.046 eV). For the nanocomposite with the minimum nanopore diameter (2.8 nm), the number and depth of traps, as well as their distribution over energies, decrease significantly; only two activation energies (0.032, 0.046 eV) are observed, which coincide with the energies of quanta of symmetric optical vibrations of the polymer. The disappearance of some vibrations can be associated with the change in the processes of charge carriers' recombination as a result of different nature of their diffusion in the films and in the nanocomposites with small pore diameter.

1. Sugakov V., Ostapenko N.I. Effect of molecular optical vibrations on thermoluminescence of silicon organic polymer // Chem. Phys. –2015. – ***456****. -P. 22-27.*