Summary

"Excitation of charge carriers in the model of semi-localized transitions SLT"

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Kinetic models relating to the phenomenon of thermoluminescence (TL) describe the processes of the release of trapped charge carriers' by thermal stimulation, their transport within the bulk as well as subsequent retrapping and recombination. For these purposes the simple trap model (STM) and the localized transitions (LT) model are often used. Recently developed generalization of these two basic models is the model of semi-localized transitions (SLT). Initially, the SLT theory described only the final stage of TL phenomenon, i.e. the heating stage.

In this paper an attempt to broaden the SLT model is presented so, that it could describe also the initial stage of TL, i.e. excitation by high energy radiation, as well as subsequent free relaxation. This, possibly, may lead to the unification of kinetic and dosimetric considerations studied in this field for several decades. For this purpose mathematical description of charge carriers' transitions between energy levels was proposed, including a diagram of evolution of states and corresponding system of differential equations. These equations were solved numerically. This allowed us to study time dependencies of all variables of the model. The influence of absorbed dose on TL glow curve emission was examined for a broad range of parameters. The possibility of the influence of radiation power on TL dosimeter response (so called dose rate effect, DRE) was studied also.

The calculations of two initial stages of TL (excitation and free relaxation) determine boundary conditions for the final stage of the TL phenomenon, i.e. the heating stage. It was found that in the SLT theory these initial conditions may strongly affect the value of the frequency factor of TL peak. This led to the formulation of the hypothesis of preferential trapping of charge carriers from the transport bands and building a variant of SLT model called ξ–SLT. Calculations based on the ξ–SLT model led to generation of TL glow curves containing peaks with very high frequency factors. Calculations of dose response characteristics within the framework of ξ–SLT model of TL dosimeter revealed many properties typically found in real detectors, e.g. superlinearity for low and high doses, a wide range of linearity and the saturation region.