Some Aspects of Scintillation Mechanism in organic Molecular Dielectrics

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Features of electron excitation energy exchange define in many respects the radioluminescence mechanism in organic materials. The study of the processes of generation, transport and recombination of charge states generated under an action of ionizing radiation allows us to describe the process of scintillation light pulse formation in organic scintillators. Besides, the results of this study are very important to analyze an influence of structure of organic systems on their radioluminescence mechanism [1]. The processes of electron excitation energy exchange proceed in different ways in the regions of high density of activation (tracks, spurs, blobs of particles) and in the regions of low density of activation (which is outside of particle track) (See, Figure 1). These processes determine the aspects of formation of delayed radioluminescence and prompt one, correspondingly.

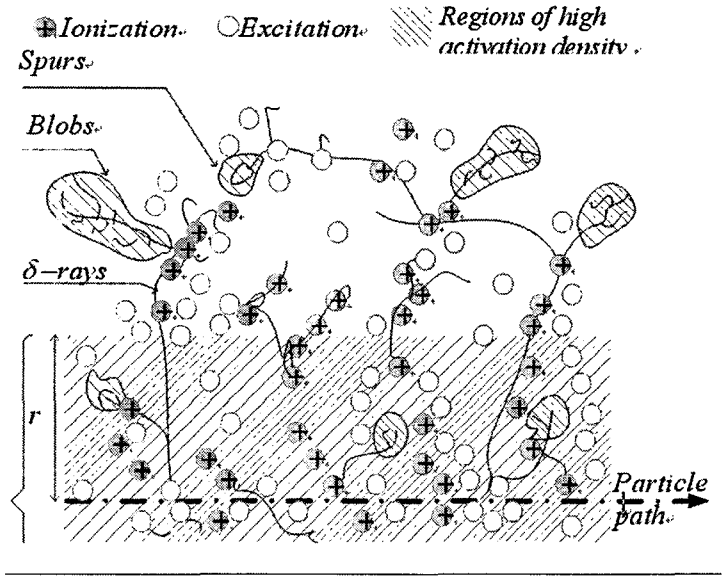

Figure 1. Schematic presentation of the initial processes of excitation of organic medium by ionizing particle with high specific energy losses.

The process of annihilation of triplet (T) states, which are mainly generated in the regions of high activation density results in slow component formation of the radioluminescence pulse.

$$T_1 + T_1 \Rightarrow \begin{cases} S_1 + S_0 \Rightarrow h\nu + 2S_0 \\ T_1 + S_0 \\ Q + S_0 \\ .... \end{cases}$$

We have studied the mechanism of concentration-controlled triplet-triplet ($T-T$) annihilation that causes bimolecular quenching of luminescence. It allowed investigating the nature of the specific quenching of triplet states in organic molecular systems. Since t> 50 ns the process of T-T annihilation becomes quasi-stationary. Features of $T-$ states diffusion define slow component formation since t > 50 ns.

The process of charge states energy exchange in the regions of low density of activation causes formation of dynamical trapping centres of polarization origin (See, Figure 2). Therefore, for organic molecular solids, in contrast to liquids, the additional delay of the moments of radioluminescence photons emission is observed. This delay is caused by the localization process of charge states on shallow traps system of structure and polarization origin.It has been shown that the Gaussian form of function describing this delay is due to a plurality of acts of generation and recombination of dynamic charge states of polarization origin.

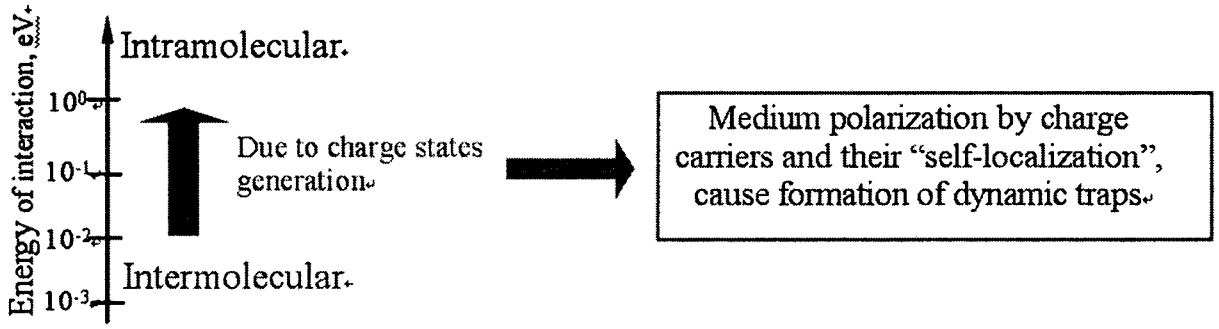

Figure 2. An influence of charge states energy exchange in the regions of low density of activation of organic solids.

As the objects of investigation we used organic single crystals and polycrystals (on the base of stilbene and p-terphenyl), plastic polyvinyltoluene scintillators and liquid scintillators on the base of toluene. To study a time distribution of photons in a radioluminescence pulse we have used a single-photon technique [2 -4].

[1] Galunov N.Z., Seminozhenko V.P., *Theory and practice of the radioluminescence of organic condensed media*, Naukova Dumka, Kiev (1997) [in Russian].

[2] Budakovsky S.V., Galunov N.Z., Rybalko A.Yu., Tarasenko O.A., Yarychkin V.V. // *Molecular Crystals & Liquid Crystals*. 2002. Vol. 385. P.71-77.

[3] Galunov N.Z., Baker J.H., Budakovsky S.V., Tarasenko O.A., Rybalko A.Yu., Yarychkin V.V. // *Journal of Luminescence*. 2003. Vol.102-103. P.464-468.

[4] Baker J. H., Galunov N. Z., Stepanenko A. M., Tarasenko O. A. // *Radiation measurements*. 2004, - Vol. 38, No.4 6, P. 817 - 820