RADIOTHERMOLYUMINESCENCE OF THE ELEKTROAKTIVITY COMPOSITES POLYMER-PIEZOKERAMIKS

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ABSTRACT

The purpose of present work is the investigation of radiothermoluminescense (RTL) of polymer-piezoceramics composites to study structural transitions, particularities of charge stabilizations in composites dependence on degree of the filling (up to 50% vol.) and γ - radiation dose (up to 3 $\cdot 10^4$ Gy). These researches allow to get information on intensities of relaxation processes in multiphase system.

It is shown, that with increase of dose of γ- irradiation the nature of change of temperature of the first maximum T_m for PEHD and its composites significantly differs. We suppose, that this is connected with shallow impurities formed by filler particles. Actually, the activation effective energy of low temperature γ-processes decreases with increasing of filling degree. It is observed, that dependencies of intensities of low temperature maximum and values of effective density of electret charge on volume content of piezophase practically coincide.

1. INTRODUCTION

Elektroaktivity (the electret, pyezo- and piroelectrical) characteristic of the poliphase (two and more) systems on base polymer and piezoceramica of the fillers are defined, alongside with type of coherence and natures of the fillers and particularity passing in them electronic-ion, polyarization processes in separate phase, and on border of the section of the phases [1-3] .As well known [3-5] that kinetics of the shaping these characteristic greatly depends on nature passing relaxation characteristic these material. Besides, on efficiency of the shaping electroaktivity characteristic polymeric composites (PK) also affects and between of the phenomena formation three-dementional charge and etc. [6,7] .In particular, earlier us was shown that polarizations condition brings about recapture stabilized on trap charge with the result that dielectrical of the loss in electrets film PE and PP fall [3,7] .Together with that, role structured and unequilibrium of the processes in shaping electroaktivity characteristic composites is studied it is not enough. Follows to emphasize that special actuality gain radiation technological questions bound, as with reception radioelectrets, photoelectrets from PK, so and under radiation and structured modification their electroaktivity characteristic. Possible expect that study relaxation characteristic PK method radiothermoluminescence (RTL) will allow and reveal some particularities of aquisition electroaktivity characteristic polymeric material, define the place to localizations surplus charge on trap to nature miscellaneous. In work [9] methods RTL are studied presence of the temperature structured transition in polymeric composites on base $BaTiO_3$ and is discovered offset of the positions -a turning the polymeric matrix in area of the low temperature with increase the contents piezofillers. Besides, the authors [9] suppose that in area of the temperature 4,2K before 500K there are presence number indicative temperature important check in hard KM Introduces at importance multiple values 12,5K. And studies working characteristic electroaktivity KM under these indicative temperature. No united opinion of the molecular mechanism of the shaping electrets and piezocharacteristic in radiation-modified PK. The method RTL finds broad using at study of compatibility component and row other characteristic in PK and their modification [8,10].

The Purpose given work is a study by method RTL change the temperature structured transition, particularities to stabilizations charge depending on -γ irradiations and degree of the filling polymeric composites. Presence structured transition in PK registered on crooked RTL are connected with change the molecular mobility of the kinetic units in area α-, β- and γ- transition.

The curve RTL presents itself row peak phosphorescences, appearing in result recombinations stabilized in process of the irradiation under low temperature charge. The peaks of the phosphorescence appear because of increase the velocities to recombination charge in interval relaxation or phase transition so position peak phosphorescences (the peak RTL) is closely connected with phase-modular by condition, ramified, presence of the admixtures and etc, in particular with particularity passing relaxation or phase transition [5-8].

2. THE EXPERIMENTAL PART

The object of the studies were a compositions on base of the polyethylene of high density (HDPE) with piezoceramics filler PKR-3M family zirkonate-titanate - a lead (PZT) after - γ irradiations under 77K depending on dose (D) of the irradiation and three-dementional contents piezophase (F). Samples composites in the manner of disk got from homogeneous mixture powder polymer-piezoceramica [3]. The sizes of the particles piezophase varied from 63 before 100 мкм.

The samples used for RTL analysis, fitted on bottom of the stainless cup by diameter 8 mm, were covered by stainless net for leaving the light. Before irradiation sample in cup vacuum in glass ampule before pressure $1{,}33 \cdot 10^{-3}$Pa, sealled the ampule and coolled before the temperature 77K submersion in container Duara with liquid nitrogen. Time vacuum t, necessities for removing dissolved in sample gas defined in dependencies from thickness film on formula:

$$t = h^2 / 4K$$

where h-thickness film, K-coefficient diffusions of the air in polymer $\approx 10^{-3}$м^2/c with [8].

The irradiation was conducted γ-radiation ^{60}Co on installation PH-γ -30 at the temperature 77K.Capacity of a dose formed $3{,}3 \cdot 10^3$Gy/oc. RTL spectrums left on instrument TLG-69M, described in [8] ,at velocities of the heating 12 degree/min in interval of the temperature from 77 before 300K. Reproducible positions maximum RTL, as a rule, formed 2-3 degrees. The Phosphorescence sample is registered in interval 300-820 nm by means of photoelectration multiplier FEU-51.Temperatura sample registered the thermocouple copper-constant.

The efficient energy to activations E_a, corresponding to γ- and β-a processes, defined the method "halfwidth» [11] maximums RTL. Calculations were made on formula:

$$E_a = \frac{1{,}42kT_mT_-}{T_m - T_-} = \frac{0{,}98kT_mT_+}{T_+ - T_m}$$

Here - T_m temperature of the maximum to intensities on crooked RTL; ΔT_- and ΔT_+ -temperature in lovetemperature and hightemperature sides, To- constant Bolsman. Got importances E_a are provided in table 1.Seperate importances Ea were have compared with importances E_a got on method of the initial velocities.

Table 1. Change of importances E_a (eV) γ and β transition depending on dose of the irradiation sample composites on base HDPE with different contentses F filler PKR-3M.

F, D, кGy % vol.	5	15	30
0	0,196	0,247	0,289
5	0,113	0,170	0,153
10	0,125	0.180	0,190
30	0,145	0,195	0,214
50	0.175	0,125	0,241

3. RESULTS AND DISCUSSION

On fig.1 broughted curves RTL source HDPE (the curve 1) and composites on its base (the curves 2-5) after - an irradiations under 77K and dose $3 \cdot 10^4$ Gy. Such picture exists and at importances of the absorbed dose $5 \cdot 10^3$ and $15 \cdot 10^3$Gy. As can be seen from drawing curve RTL clean HDPE, basically, has two maximums of the phosphorescence; love temperature first maximum under 169K and comparatively high temperature second peak under 250K accordingly. After modification HDPE introduction PKR-3M following change comes to light on crooked RTL: introduction 5% PKR-3M in HDPE enlarges the intensity of the phosphorescence both peak, shifts the temperature of their maximum aside low temperature. The further increase degree filling brings about reduction of the intensities first peak, disappearance second peak and shift of the temperature of the maximum first peak (T_m) composites for high temperature aside. Herewith, T_m first peak HDPE remains above, than T_m composites.

On warm-up position peak phosphorescences possible to them with γ- and β- transition in HDPE [3,10] .Usually γ -transition is conditioned with bendability by fluctuations several atoms of carbon main circuit polymer, or with motion separate

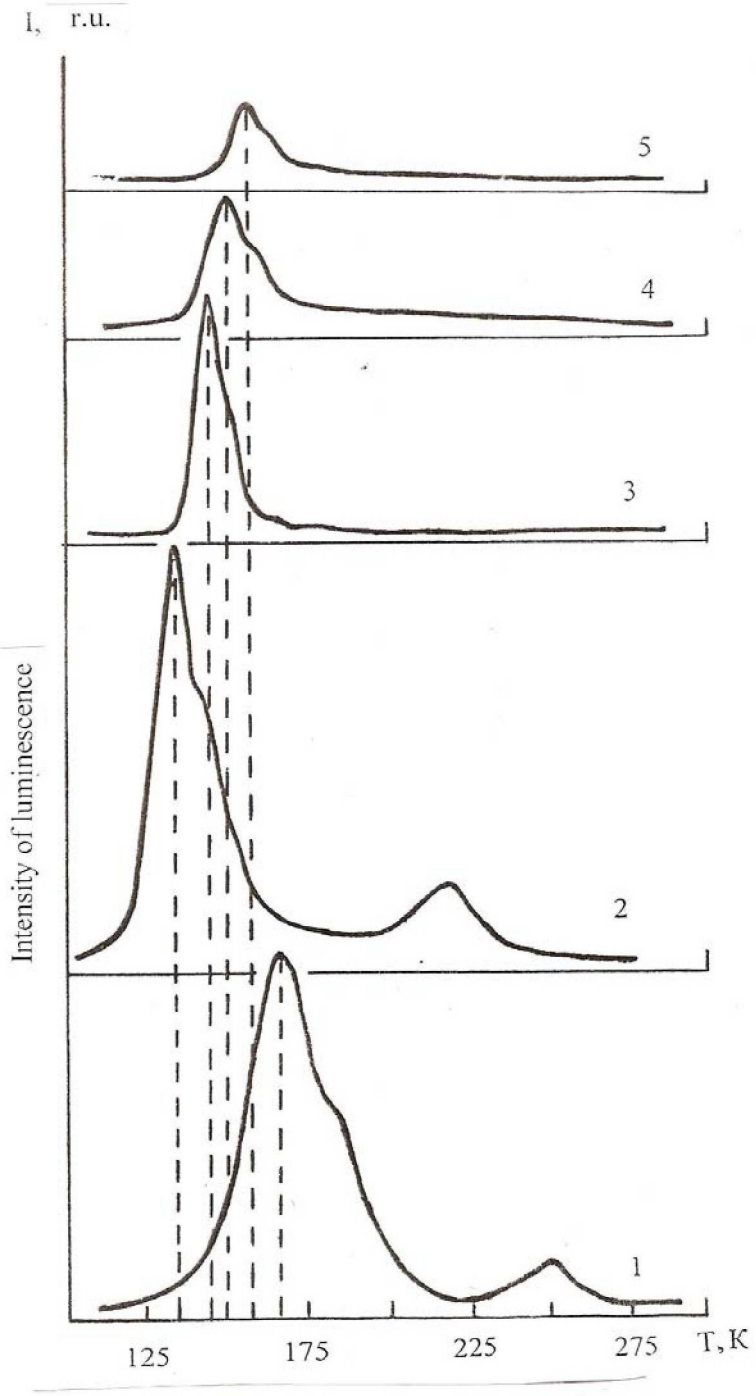

Fig.1. A plot of intensity of RTL versus T.

segment on surfaces polymeric crystal. The second peak under 250K characterizes the process classed HDPE and this process is referred to as β - transition.

Increase to intensities of the phosphorescence under F=5% vol.PKR-3M shows that structured change; occurring herewith polymeric phase brings about formation new centre (the trap) for stabilization charge. But reduction of the amplitude of the maximum RTL composites with increase the three-dementional contents possible to explain the reduction of the share pettiscale segmenting to mobilities. The temperature of the maximum β - transition is displaced aside low temperature that is indicative of that, that with entering the filler is suppressed β -relaxation process in HDPE.

On fig.2 is brought dependencies T_m (D) of the phosphorescence RTL from dose of the irradiation D for HDPE (the curve 1) and its composites (the curves 2-4) by three-dementional contentses piezophase 5,10 and 30% vol. accordingly. It is seen that with increase D nature of the change T_m for HDPE and its composites greatly differs for one another. If for HDPE importance T_m it increases from 150 before 169K then monotonous reduction of importances T_m .This exists for composites HDPE can be connected with quite intelligent defect centre, conditioned particle of the filler. Really, efficient energy to activations lovetemperature γ - process falls with increase degree filling.

The big interest with standpoint of the creation more efficient electrets composites present the results of the study of the change the position and amplitudes love temperature maximum RTL depending on volume of the contents piezophase PKR-3M (fig.3). It is seen that with increase F piezophase and, consequently, share of the polymeric phase in приповерхностных layer mobility of the polymeric circuits decreases with piezoparticles and their kinetic units responsible for shaping RTL. With specified effect somewhat possible to the phenomenas of the more high flashing composites with volume by contents piezophase F=5%, subject to action γ - radiations.

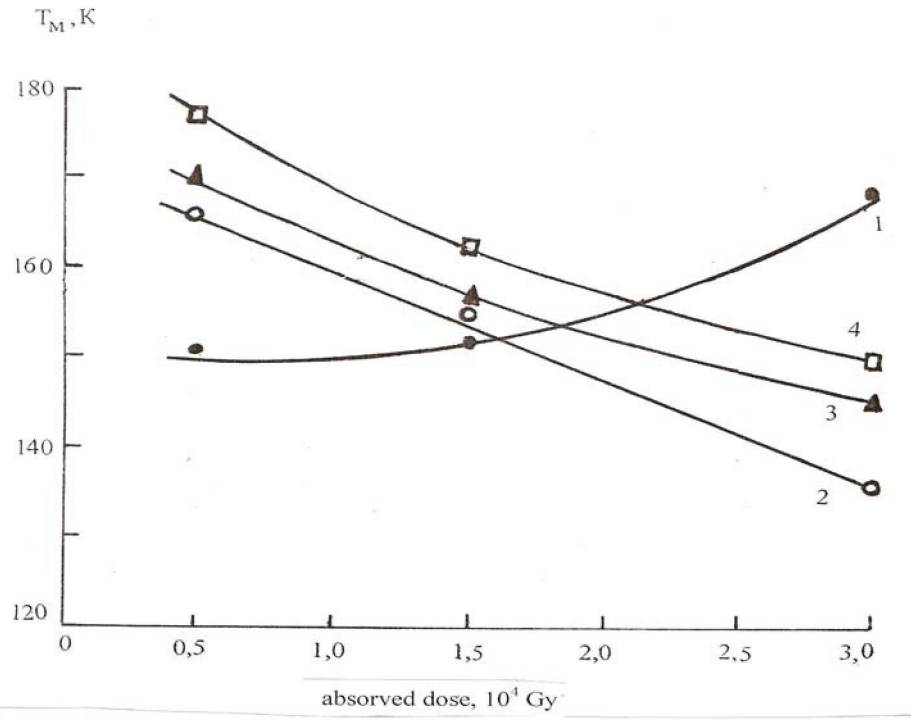

Fig.2. The variation of the T_m of the γ-peak versus irradiation dose as a function of vol.% PKR-3M for HDPE (curve 1) and its composites (curve 2,3,4).

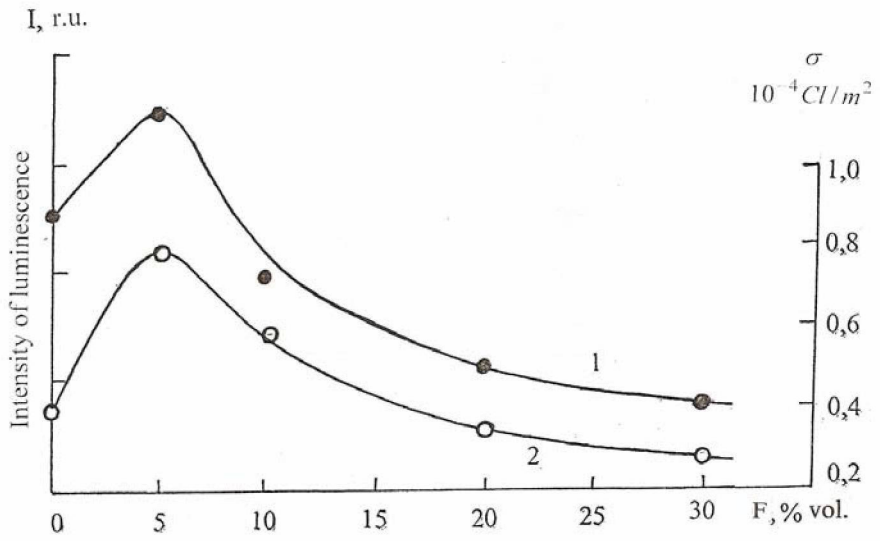

Fig. 3. Dependence of intensity of RTL γ-peak (1) and stable surface charge density (2) on PKR-3M vol.%.

Us are also discovered that dependencies to intensities of the flashing love temperature maximum and values to efficient density of the charge (the electrets of the charge) from volume of the contents piezophase practically coincide (the fig. 3). This shows that at volume contents piezophase F=5% structured change (which occur in polymeric phase under its dispersion, defining spectrum localized level in quaforbidden band zone of the polymer) are optimum with standpoint of the stabilizations charge and under γ- irradiation (RTL, radioelectret).

Thereby, study RTL spectrum composites possible to forecast shaping high electrets conditions in composites polymer-piezoceramica.

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