DIELECTRIC PROPERTIES OF POLYMER COMPOSITES WITH SEMICONDUCTOR FILLER $TlIn_{0.98}Ce_{0.02}Se_2$.

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In the present work the dielectric properties of polymer compositions with filler $TlIn_{0.98}Ce_{0.02}Se_2$ have been obtained and investigated. It has been revealed that the dependence of $tg\delta$ and ε on temperature is connected with the dependence of relaxation time on temperature.

Introduction

Last years the investigations in the field of material formation with special and practical important electrophysical properties on the base of polymer composites containing the semiconductors have been widened. The improvement of polypropylene (PP) electroactive properties at filler introduction are mainly connected with two circumstances: filler particles play role of structure formation center and polymer interface with filler has the special saturation structure of trapping centers with different energy activation values at which the electrons stabilize [1]. Note that the obtained polymer composition can be current-conducting, antistatic or dielectric one in the dependence on nature, dimension, form, distribution character of the filler. By these reasons the conclusions of different authors in respect to the revealing nature of either composite electroactive properties at filling of polyolefines by different piezofillers, are different [2].

The filler of organic and inorganic nature are used for obtaining of new compositional materials. Last years the relatively new works where the triple semiconductor compounds of TlSe type [3] are used as fillers have appeared. As a result of the given investigations it has been revealed that PEVP+$TlInSe_2$ and PP+ $TlInSe_2$ compositions are high-qualitative electret materials with life times in 5÷13 times more than one of pure polymers.

In the present work the dielectric properties of polymer compositions with $TlIn_{0.98}Ce_{0.02}Se_2$ addition are considered.

Experimental part

The polymer powder (polypropylene) is mixed with semiconductor material one for obtaining of polymer composite. Then the films of thickness 100 mcm at melting point of polymer matrix and pressure 10÷15MPa between aluminum foil are pressed from the mixture. The obtained samples with foil are rapidly cooled in the water and then the foil is removed. After that the given films are polarized in corona discharge in the needle-plane electrode system of 6kV voltage during $3 \cdot 10^2$ sec. The distance between needle and plane is chosen $\sim 1 \cdot 10^{-2}$ m.

The addition of semiconductor material $TlIn_{0.98}Ce_{0.02}Se_2$ in relation 3÷5 vol.% forms the polymer composition in relation 95÷97vol.%. The samples are obtained by hot pressing from mixture of powders and $TlIn_{0.98}Ce_{0.02}Se_2$ filler with dispersion up to 50 mcm.

The powder mixing of polymer and filler is carried out on laboratory mill at room temperature and then by hot pressing at 10^7Pa.

The electret-thermal analysis is carried out by standard method [4] where composites are put between two electrodes shorted through electrometric voltmeter B7-42 in heated measuring cell [5]. The spectrum recording of thermostimulated depolarization current in range 293-523K is carried out at temperature linear growth of the sample with the velocity 5K/min.

The sample thickness and upper electrode diameter (for square obtaining) are measured with the help of trammel. For the measurements the sample is put between two plane electrodes of circle form. The measurements are carried out automatically. The measurements of capacity and dielectric loss tangent are carried out simultaneously.

The sample capacity *(C)* is measured for obtaining of dielectric constant (ε). The material dielectric constant is carried out by measured values of capacity, sample thickness and electrode square.

The dielectric constant (ε) is calculated by formula:

$$\varepsilon = \frac{Cd}{\varepsilon_0 S}$$

where C is measured sample capacity, F; ε_0=8,85·10^{-12}F/M; d is sample diameter, m; S is sample square,m^2.

The dielectric loss tangent $tg\delta$ is measured indirectly.

Thus the capacity and dielectric loss tangent corresponding to the frequencies 1kHz should be measured for each of chosen dielectrics.

The sample is put between two electrodes in measuring cell. Then the sample is heated with constant velocity 2K/min in the cell with the help of heater which is embedded into the cap. The sample temperature is registered with the help of thermocouple and temperature measurer but dielectric constant and dielectric losses are registered with the help of measuring bridge LCR E7-8. The heating with constant velocity is possible with the help of the three-later system.

Results and their discussion

The influence of filler content on temperature dependences of dielectric constant $\varepsilon(T)$ of PP/$TlIn_{0.98}Ce_{0.02}Se_2$ composites is shown on fig.1. It is seen that ε value increases with increase of $TlIn_{0.98}Ce_{0.02}Se_2$

content in the composition on the base of PP and the some additional growth of ε values is observed on $\varepsilon(T)$ dependence (fig.1) at polymer softening temperature.

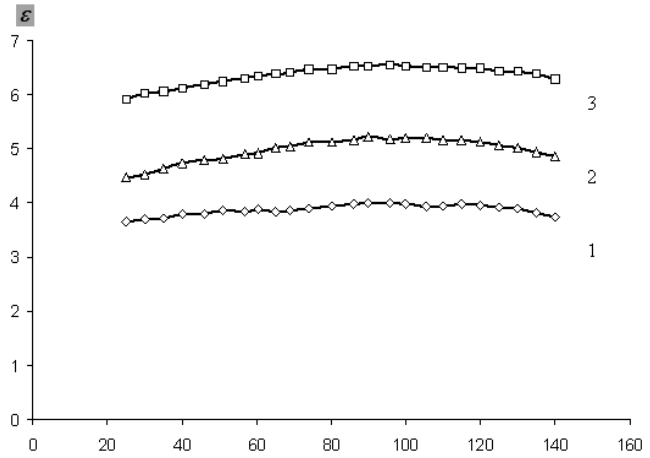

Fig. 1. Temperature dependences of dielectric constant $\varepsilon(T)$ ПП/ $TlIn_{0.98}Ce_{0.02}Se_2$ at filler content 1-(3%), 2-(5%), 3-(10%).

The investigation results of $tg\delta=f(t)$ dependence of PP/ $TlIn_{0.98}Ce_{0.02}Se_2$ compositions are presented on fig.2.

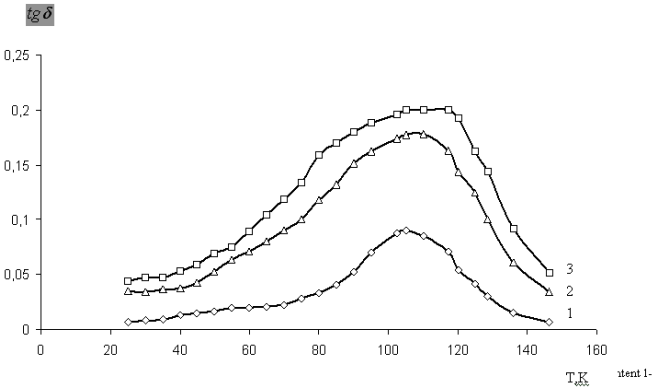

Fig.2. Temperature dependences of dielectric losses $tg\delta(T)$ of $TlIn_{0.98}Ce_{0.02}Se_2$ compositions at filler content 1-(3%), 2-(5%), 3-(10%).

As it follows from fig.2 the $tg\delta=f(t)$ dependences pass through maximums. Such behavior of curves is obviously connected with τ relaxation time change with temperature. The dipole macromolecules practically don't orientate that is equivalent to "elastic" response at low temperatures when τ is big and essentially more than field change period. $tg\delta$ begins to rapidly growth when relaxation time decreases up to the value close to field change period as a result of temperature increase. The maximum appears on $tg\delta=f(t)$ curve at $\omega=1/\tau$ condition. The dielectric losses decrease again at the further relaxation time decrease because of temperature increase.

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$TlIn_{0.98}Ce_{0.02}Se_2$ ƏLAVƏLİ POLİMER ƏSASLI KOMPOZİTLƏRİNİN DİELEKTRİK XASSƏLƏRİ

İşdə $TlIn_{0.98}Ce_{0.02}Se_2$ əlavəli polimer əsaslı kompozitlər alınmmış və dielektrik xassələri tədqiq edilmişdir. Aşkar edilmişdir ki, ε və $tg\delta$ - in temperaturdan asılı olaraq dəyişməsi relaksasiya müddətinin temperaturdan asılı olaraq dəyişməsi ilə əlaqədardır.

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ДИЭЛЕКТРИЧЕСКИЕ СВОЙСТВА ПОЛИМЕРНЫХ КОМПОЗИТОВ С ПОЛУПРОВОДНИКОВЫМ НАПОЛНИТЕЛЕМ $TlIn_{0.98}Ce_{0.02}Se_2$

В работе получены и исследованы диэлектрические свойства полимерных композиций с наполнителю **$TlIn_{0.98}Ce_{0.02}Se_2$**. Выявлено, что изменение $tg\delta$ и ε с температурой связано с изменением времени релаксации с температурной.

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