THE INFLUENCE OF ELECTROTREATMENT ON MECHANICAL AND ELECTRIC DURABILITIES OF COMPOSITIONS ON THE BASE OF POLYMERS AND PIEZOCERAMICS

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The influence of preliminary electrotreatment on mechanical and electric composition durabilities on the base of polyethylene (PE), polyvinylidene fluoride (PVDF) and piezoceramic (PCR5) is investigated. It is shown, that mechanical and electric durabilities of PE+30vol%PCR5 and PVDF +30vol%PCR5 compositions increase at first and then decrease in the dependence on electric field intensity of E_{treat} electrotreatment, that is connected with increase and decrease of interphase interactions.

The study of electrotreatment influence on composition strength properties on the base of polymers and piezoceramics presents the scientific and practical interest as they are the main elements in the devices of different sensing elements and transformers and are treated by the influence of external factors, including electric field [1-3].

In the given work the investigation results of electrotreatment influence on mechanical and electric durabilities of PE+30vol%PCR5 and PVDF+30vol%PCR5 compositions are presented.

PCR5 piezoceramics has the content of zirconato-titanate-lead (ZTL) and the rhombohedral structure.

The compositions are prepared by the method of hot pressing of mechanical mixture from piezoceramics powders PCR5 and PE and PVDF polymers separately at melting point of polymer matrix under the pressure 150 MPa during 10 min with the postcooling.

The logarithm dependence of mechanical durability $lg\tau_\sigma$ on mechanical bursting stress σ for PE+30vol%PCR5, preliminary treated by electrotreatment at different values of electric field intensity E_{treat} are presented on the fig. 1. It is seen, that $lg\tau_\sigma$ linearly decreases in the dependence on σ in all cases, i.e. the exponential dependence takes place

$$\tau_\sigma = Ae^{\alpha\sigma}, \qquad (1)$$

where A and α are parameters, depending on the nature of investigated material and test temperature on mechanical durability.

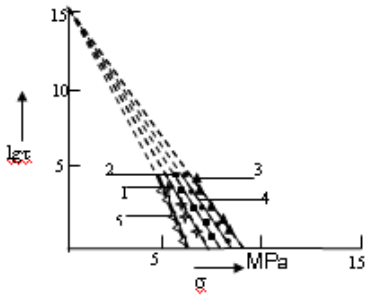

Fig. 1. The dependence of mechanical durability of PE+30vol%PCR5 compositions preliminary treated by electrotreatment on the mechanical bursting stress: 1- E=0; 2-E=10; 3-E=11; 4-E=12; 5-E=14·10^{6}V/m.

From the fig.1, it is also seen, that the mechanical durability $lg\tau_\sigma$ of PE+30vol%PCR5 compositions increases at first and then decreases in the dependence on electrotreatment E_{treat} intensity at other equal conditions.

The dependences of logarithm of electric durability $lg\tau_E$ on breakdown electric field intensity E for PE+30vol%PCR5 compositions, preliminary treated by electrotreatment at different values of electric field intensity E_{treat} are given on the fig.2. It is seen, that here the exponential dependence is also carried out:

$$\tau_E = Be^{-\beta E}, \qquad (2)$$

where B and β are parameters, depending on the nature of investigated material and test temperature on electric durability.

From the fig. 2 it is also seen, that here the electric durability $lg\tau_E$ of PE+30vol%PCR5 compositions in the dependence on electrotreatment E_{treat} intensity firstly increases, and further decreases at other conditions.

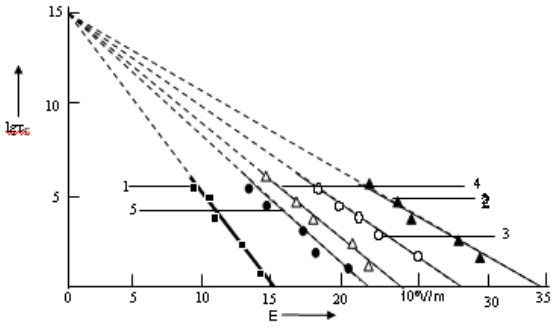

Fig. 2. The dependence of electric durability of PE+30vol%PCR5 compositions preliminary treated by electrotreatment on electric field intensity; 1- E_{treat} =0; 2- E_{treat} =10; 3- E_{treat} =11; 4- E_{treat} =12; 5- E_{treat} =14·10^{6}V/m.

The dependences of $lg\tau_\sigma$ on σ and $lg\tau_E$ on E for PVDF+30vol%PCR5 compositions preliminary treated by electrotreatment at different values of electric field intensity E_{treat} are shown on the figures 3 and 4. It is seen, that the exponential dependences (1) and (2) take place for PVDF+30vol%PCR5 compositions. By other hand, as it is seen from the figures 3 and 4, the mechanical durability $lg\tau_\sigma$ and electric one $lg\tau_E$ of PVDF+30vol%PCR5 compositions in

the dependence of electrotreatment E_{treat} intensity increase at first and then decrease at other equal conditions.

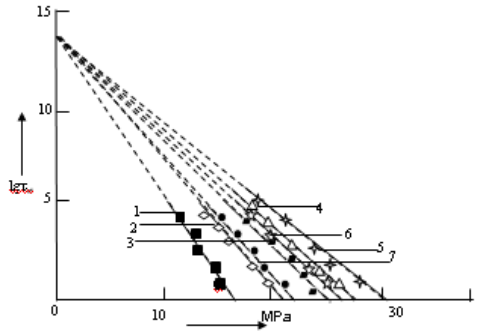

Fig. 3. The dependence of mechanical durability of PVDF+30vol%PCR5 compositions preliminary treated by electrotreatment on mechanical bursting stress;
1- E_{treat} =0; 2- E_{treat} =3; 3- E_{treat} =5; 4- E_{treat} =8; 5- E_{treat} =10; 6- E_{treat} =12; 7- E_{treat} =15·10^{6}V/m.

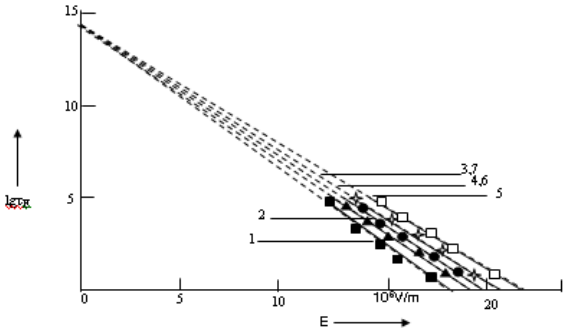

Fig. 4. The dependence of electric durability of PVDF+30vol%PCR5 compositions preliminary treated by electrotreatment on electric field intensity;
1- E_{treat} =0; 2- E_{treat} =3; 3- E_{treat} =5; 4- E_{treat} =8; 5- E_{treat} =10; 6-E=12; 7- E_{treat} =15·10^{6}V/m.

The fact, that dependences $lg\tau_\sigma$ on σ and $lg\tau_E$ on E at extrapolation σ =0 and E =0 cross at a point of ordinate axis on the figures 1,2,3 and 4, pays attention. By other words, A and B parameters in formulae (1) and (2) are constant, and changes of strength properties (of mechanical and electric durabilities) reflect in changes of α and β parameters.

It is known, that temperature-force dependence of mechanical durability $\tau_\sigma=f(T,\sigma)$ of polymer compositions is expressed by Jurkov's formula [4]:

$$\tau_\sigma = \tau_0 e^{\frac{U_0-\gamma\sigma}{KT}} \qquad (3)$$

and temperature-field dependence of electric one $\tau_E=f(T,E)$ of polymer compositions is expressed by formula, which is analogical to Jurkov's one:

$$\tau_E = \tau_0 e^{\frac{W_0-\chi E}{KT}} . \qquad (4)$$

Here U_0 and W_0 parameters are activation energies of processes of mechanical and electric destructions, and χ and γ are structural-sensitive coefficients, correspondingly.

From the comparison of formula (1) with formula (2) and formula (2) with formula (4) we can write the following expressions:

:

$$A = \tau_0 e^{\frac{U_0}{KT}} , \qquad \alpha = \frac{\gamma}{KT}$$

$$B = \tau_0 e^{\frac{W_0}{KT}} , \qquad \beta = \frac{\chi}{KT}$$

From the figures 1-4 it is followed that A=*const* and B=*const* at T=*const*, therefore U_0=*const* and W_0=*const*. This means, that the changes of mechanical and electric durabilities of PE+30vol%PCR5 and PVDF +30vol%PCR5 compositions in the dependence on intensity E_{treat} at their electrotreatment don't reflect in changes of U_0 and W_0, i.e. they stay constant (permanent) and these changes are connected with the ones of structural-sensitive coefficients χ and γ, since α and β parameters change at that. Consequently, the values of activation energies of mechanical destruction U_0 and electric one W_0 stay constant at preliminary electrotreatment of PE+30vol%PCR5 and PVDF +30vol%PCR5 compositions, and changes of their strength properties in the dependence on E_{treat} are connected with the ones of physical structure, that reflects in the changes of structural-sensitive coefficients γ and χ.

The observable changes (increase and decrease) of mechanical and electric durabilities of investigated compositions in the dependence on electrotreatment E_{treat} intensity, probably, are connected with the ones (amplification and weakening) of interphase interactions.

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POLİİMERLƏR VƏ PYEZOKERAMİKA ƏSASINDA ALINMIŞ KOMPOZİSİYALARIN MEXANİKİ VƏ ELEKTRİK YAŞAMA MÜDDƏTLƏRİNƏ ELEKTRİK SAHƏSİNDƏ İŞLƏNMƏNİN TƏSİRİ

Polietilen (PE), polivinilidenftorid (PVDF) və PKR5 pyezokeramikası əsasında alınmış kompozisiyaların mexaniki və elektrik yaşama müddətlərinə onların əvvəlcədən elektrik sahəsində işlənmənin təsiri tədqiq edilmişdir. Göstərilmişdir ki, elektrik sahəsində işlənmənin $E_{işl}$

intensivliyindən asılı olaraq PE+30h%PKR5 və PVDF+30h%PKR5 kompozisiyalarının mexaniki və elektrik yaşama müddətləri əvvəlcə artır və sonradan isə azalırlar. Bu isə fazalararası qarşılıqlı təsirin artması və azalması ilə əlaqədardır.

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ВЛИЯНИЕ ЭЛЕКТРООБРАБОТКИ НА МЕХАНИЧЕСКУЮ И ЭЛЕКТРИЧЕСКУЮ ДОЛГОВЕЧНОСТЬ КОМПОЗИЦИЙ НА ОСНОВЕ ПОЛИМЕРОВ И ПЪЕЗОКЕРАМИКИ

Исследовано влияние предварительной электрообработки на механическую и электрическую долговечность композиций на основе полиетилена (ПЭ), поливинилиденфторида (ПВДФ) и пъезокерамики ПКР5 . Показано, что в зависимости от напряженности электрического поля электрообработки $E_{обр.}$ механическая и электрическая долговечности композиций ПЭ+30об.%ПКР5 и ПВДФ+30об.%ПКР5 сначала увеличиваются, а затем уменьшаются, что связано с усилением и ослаблением межфазных взаимодействий.

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