

ENERGY TECHNOLOGY ACTIVATION COMPONENTS FUNCTIONAL MATERIALS BASED ON POLYMERIC MATRIX

ЭНЕРГЕТИЧЕСКИЕ ТЕХНОЛОГИИ АКТИВИЗАЦИИ КОМПОНЕНТОВ ФУНКЦИОНАЛЬНЫХ МАТЕРИАЛОВ НА ОСНОВЕ ПОЛИМЕРНЫХ МАТРИЦ

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Abstract: Investigated the mechanisms of interfacial interactions in composite materials based on thermoplastic matrices modified with dispersed particles of silicon and carbon-containing compounds with high energy activity. It was found that the laser treatment of particulate and fibrous particles occurs comprehensive modification of the surface layer, which consists in shaping the development of the morphology of the surface layer and increase its energy. For the modification of thermoplastic matrix including high-viscosity (polyamides, PTFE) prospectively the use of dispersed fragments of carbon fiber (CF) fraction 50-150 microns, subjected to the effects of a short pulse laser, having developed the morphology of the surface layer and the presence of defects through thermal degradation. When using this modifier in an amount of 5-30 wt.% for filling PA6, PA66, PTFE provides increased of parameters deformation and strength characteristics due to the increased mechanical component adhesive interaction at the interface of "matrix-filler". An additional effect is realized in the processing of the surface layer of CF fluoride compounds oligomeric or polymer-oligomeric structure. The modified fluorinated hydrocarbon components fragments CF when laser pulse processing are exposed to the active low molecular weight products ablation, so that the surface layers are formed with a high affinity to the matrix polytetrafluoroethylene. The complex method of modifying CF is effective for highly filled fluoro composites containing 25-35 wt.% of carbon fillers due to the decrease in the probability of formation of cluster structures of the filler particles. Dispersed particles silicate (clay, tripoli, talc) and carbon (graphite, carbon black, shungite) when exposed to laser radiation susceptible to degradation with the formation of nanoscale fragments in a moving layer, thus increasing their activity in the processes of the interfacial interaction in the formation of composites based on oligomeric and polymeric matrices.

KEYWORDS: COMPOSITES, MODIFIERS, INTERPHASE INTERACTION, MORPHOLOGY, ENERGY STATES

1. Introduction

Among the promising areas of materials science is the creation of composites based on thermoplastic matrices modified with nano-sized components of different composition, structure and habit [1-4]. The mechanism of action of modifying nanoparticles is to implement a multi-level approach, which is possible to control the processes of structural organization at the molecular, intermolecular, supramolecular and interfacial levels. Nano sized modifier, depending on their size and energy state (nano particles, nano cluster, micro particle nano dimensional topography) may form intramolecular or intermolecular physical bonds in place of the functional groups, to promote the orientation of macromolecules or their segments to form a quasi-crystalline structures, be the centers of formation of crystalline structures spherulitic type, form interfacial boundary layers increased strength.

To realize the nano particle dispersion state of the effect modifier should be in the nano size range or have developed relief of the surface layer containing nano components of different habit - whisker, plate, spherical [1-4].

An analysis of the literature and our model representations [1, 2] show preference plate nano habit modifiers or fragments thereof on micro particles, as in this case it achieved a significant effect of improving the parameters of strength and tribological characteristics when doping content modifier is (0.1-1.0) wt.%. At the same time, there are different mechanisms of formation of this habit of the particles.

The purpose of this study was to use the features of the morphology of the dispersed particles subjected to different types of energy impact.

2. Research methods

For the research were chosen components used for the production of composite materials based on polymeric and oligomeric matrix – particles carbon containing (graphite, carbon, UFD UFDG, carbon fiber), silicon-containing (clay, talc, mica, flint) and combined (shungite) products. In separate experiments the particles dispersed lamellar thermo polymers - a polyamide 6

(PA6), polytetrafluoroethylene (PTFE), ultra thermodynamic synthesis products (UPTFE).

Activation particles modifier carried the energy, thermal, laser, mechanochemical effect. The assessment was carried out activities in the parameter values of the thermally stimulated current (TSC) in the temperature range (293-523) K.

3. Results and discussion

The activity of the dispersed particles of fillers and modifiers in the process of interaction of the matrix determines the mechanisms and kinetics of formation of the structure of the boundary layer, which is correlated with the parameters of strength, tribological, thermal, adhesive and other service characteristics of composite materials based on high molecular weight matrix (Figure 1).

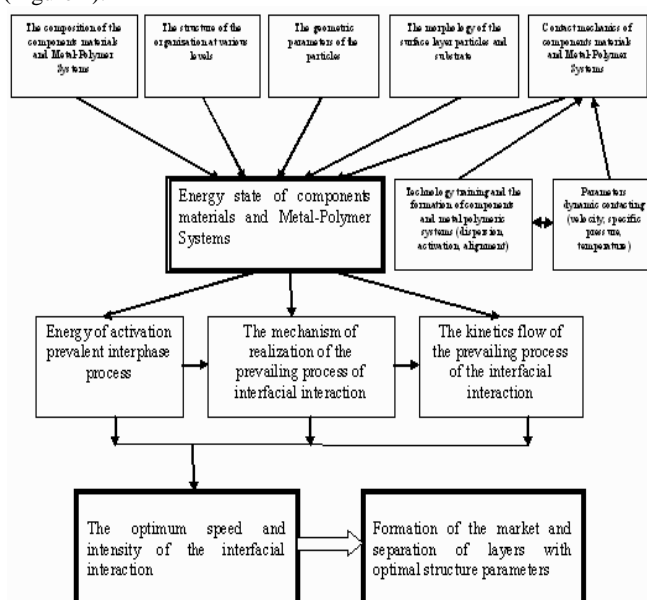


Fig. 1 The energy factor of materials science and technology of composite materials and Metal-Polymer Systems

The literature and our research suggests that the optimal modifying action the particles, which realized the effect of nano state, due to the size range or the particle itself or the individual components of its surface layer [1]. Established the basic factors determining the state of nano dispersed particles of condensed matter that allow the selection of the method of its implementation for the particular combination of the components and functionality of the composite (Figure 2).

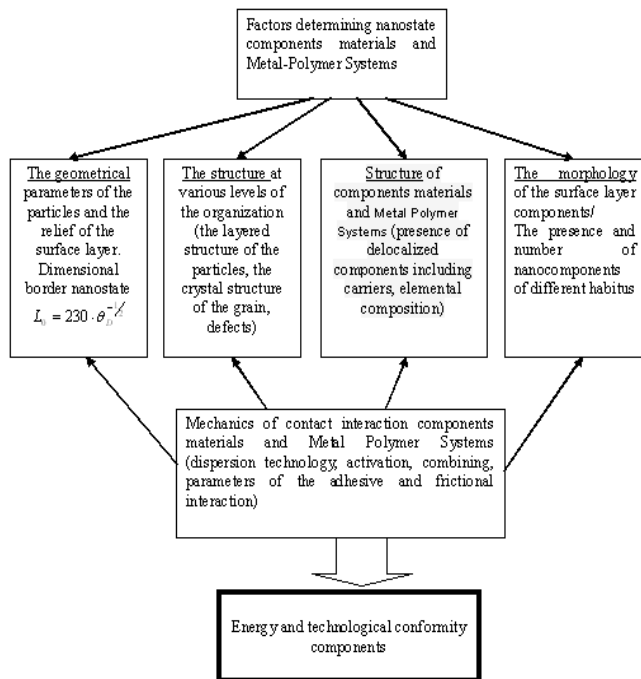


Fig. 2 Factors nanostate components material systems

To make informed choices activation technology modifiers dispersed particles of different composition, crystal-chemical structure and nature should be used L_0 parameter which determines the maximum size at which manifest the characteristics of nanostate. Parameter L_0 is determined from the analytical expression $L_0 = 230 \cdot \theta_D^{-1/2}$, where θ_D – temperature Debye.

The experimental results indicate that the provision of high-activity modifying particles may be in the micron size range with advanced morphology of the surface layer formed nanoscale components whisker, plate and spherical habit. To form such morphology a surface layer of the most promising effect on the dispersed particles of energy flows that cause the process of thermal degradation, pyrolysis, degidroksilatsii, dispersing with formation nanocomponents.

Analysis of the morphology of the surface layer of particles of different composition and structure subjected to thermal, laser and mechanochemical action, indicates the presence of the general laws of manifestation nanostate (Figure 3).

For the carbonaceous particles detonation synthesis products UFDG and colloidal graphite, obtained by flotation, increased sophistication of the surface layer is observed with the formation of nanoscale components. The effect is most pronounced when the modification of the particulate laser semifinished (Figure 3, c, f). Similar processes of dispersion of the surface layer is characterized for particle silicates (mica, clay, talc), and shungite. The particular morphology characteristic of hydrocarbon fragments, in which along with the development surface, observed through the formation of defects (cracks) by laser radiation. The close nature of the morphology of the surface layer characteristic of dispersed particles subjected to mechanical stress during acceleration (2÷20) g.

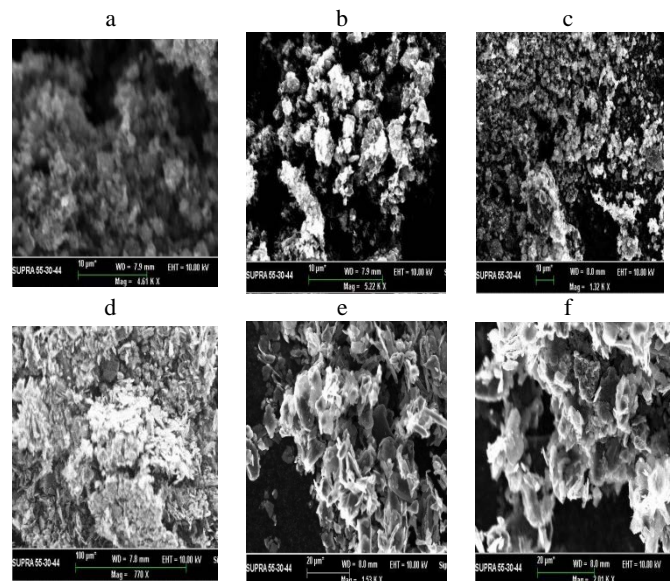


Fig. 3 A typical morphology of the dispersed particles of the charge detonation synthesis UFDG (a, b, c) and colloidal graphite C-1 (d, e, f) of the original (a, d), thermally treated (b, e) and treated with laser light (c, f). These SEM

4. Conclusions

Analysis of the energy state of the dispersed particles after different types of activation indicates an increase in the intensity of thermally stimulated currents temperature range (303-523) K. Comparison of the calculated parameter data L_0 and results TST – analysis suggests the manifestation of the dispersed particles in the micron range, subjected to various types of activation, the characteristic features nanostate. With the introduction of such particles into the polymer matrix – polyolefins (HDPE, PP), polyamides (PA6, PA6.6), polytetrafluoroethylene (PTFE) in an amount of (0.01 ÷ 1.0) wt.% is observed the effect of increasing strength and wear parameters, indicating that manifestation technically significant effect modification as a result of increased activity.

5. References

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