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ROLE KINETIC AND ELECTROPHYSICAL PARAMETERS ON CONDUCTIVITY IN SEMICONDUCTOR - POLYMER BASED THIN FILM COMPOSITES WITH DIFFERENT CERAMIC PHASE

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Abstract

- In the article, the role of kinetic and electrophysical parameters in the conduction mechanism of semiconductor-polymer based thin-film composites was studied. Interphase interactions in polymer composites are known to depend on the supra molecular structure of the polymer phase, the polarity of the macromolecules, and the surface activity of the semiconductor particles used as dispersants. A large number of experimental results studied show that interphase interactions influence the main properties of semiconducting polymer composites[1]. It should be noted that the mechanism of tunneling currents in these varistors and the presence of this effect in composites should be determined from the point of view of developing polymer-based composite varistors. Experimental investigation of tunneling conductance is difficult. Thus, there are many uncertainties in the values of physical parameters characterizing the boundary between crystallites[1-3].

- Different types of dispersants are used in order to clarify the formation of new properties in semiconductor-polymer based composites. It should be noted that by changing the types of polymers and dispersants, it is possible to prepare composites with new components in various fields of technology and to monitor the physical processes occurring in them. It should be noted that scattering analysis of the material's dielectric parameters (conductivity, dielectric loss, etc.) occupies an important place when studying the transport properties of inhomogeneous materials. The frequency dependence of the values of conductivity and dielectric loss factor depend on the electrophysical parameters of the dispersed phase and matrix. Note that the analytical calculation of the effective parameters of multicomponent systems, which are part of the dispersion theory of inhomogeneous dielectrics, is itself a very complex mathematical problem[1-16].
- When studying multi-component materials, it is important to study frequency parameters in addition to the geometrical structure of composites, electrical conductivity and dielectric properties of components[1-5].

Table 1. Critical voltage (U_{cr}) and nonlinearity factor (β) of composite varistors based on ZnO-PVDF with different additives [28]

Composites	Critical tensions (U_{cr}) V and nonlinearity coefficient(β)			
	ZnO (with additives ZrO_2) +F2M		ZnO (with additives Al_2O_3) +F2M	
	U_{cr} V	β	U_{cr} V	β
30%C+70% PVDF	215	6.8	U=140	4.86
35%C+65% PVDF	198	6.6	U=137	5
40%C+60% PVDF	182	6.35	U=125	7
50% C+50% PVDF	150	6.2	U=120	7.6
60% C+40% PVDF	130	5.7	U=117	8.7

Table 2. Critical voltage (Ucr) of composite varistors based on ZnO-PE with different additives[28]

Composite samples	Critical tensions (U_{cr}),V	
	ZnO (with additives ZrO_2) +Pe	ZnO (with additives Al_2O_3) +PE
30%C+70%PE	U=600	U=140
40%C+60%PE	U=310	U=150
50% C+50%PE	U=250	U=190
60% C+40%PE	U=200	U=120

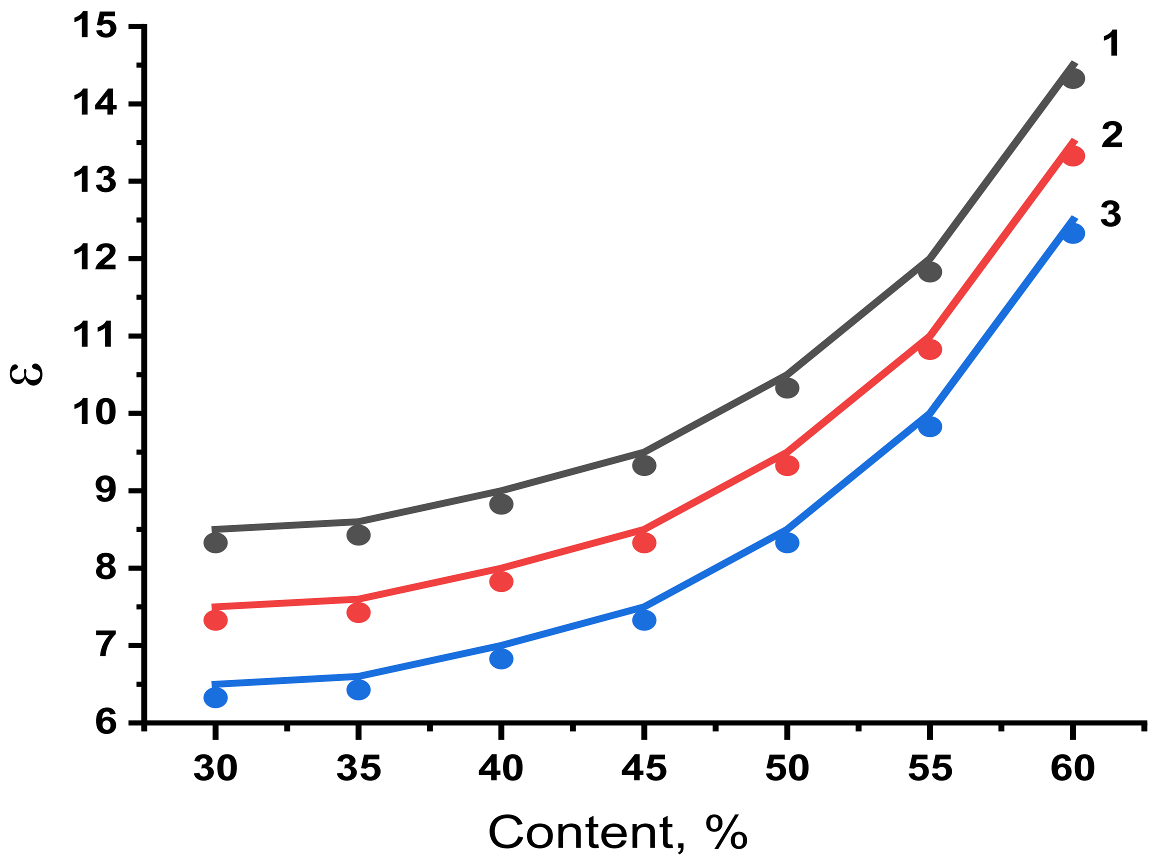

Figure. Dependence dielectric constant of the volume content filler in the ZnO- high-pressure polyethylene composite and treatment by electric discharge
(1 - untreated, 2- treated for 3 min, 3 - for 10 min) [13;25].

Table 2. Concentration of traps and electrons in ZnO-polymer composites dependence of the free flight path on the volume percentage of the composite

Examples studied	PE		PVDF	
	$\lambda*10^{-8}$ m	$N_{tr}*10^{19}$ m^{-3}	$\lambda*10^{-8}$ m	$N_{tr}*10^{19}$ m^{-3}
30% ZnO+70% polymer	1.6	0.3	7.2	0.31
35% ZnO+65% polymer	1.58	0.31	6.1	0.5
40% ZnO+60% polymer	1.52	0. 315	3.5	0.68
50% ZnO+50% polymer	1.4	0.32	2.6	0.8
60% ZnO+40% polymer	1.37	0.33	1.25	1.1

CONCLUSIONS

The analysis obtained results indicates the dependence at operational characteristics of multilayer varistor on the development of the electron-ion exchange processes at polymer phase. The size of the possible obstacle at phase boundary primarily depends on the volume percentage and size of the main structural element of ZnO ceramics. Value and resistance of the potential barrier between them ceramic particle and polymers decreases due to the increase in dielectric permeability. According to the conducted experiments, as the volume percentage of the filler increases, the value of the dielectric permeability of the composite increases. On the other hand, as a result of the increase in dielectric permeability, the value and resistance of the potential barrier between the filler particles and the polymer decreases, and as a result, the concentration of charge carriers increases. Considering that ZnO and SiC ceramics are polycrystalline materials and their degree of crystallization is very small, it can be said that the density of the amorphous phase in the composite increases as the volume percentage of the filler increases. In other words, the number of defects in the composite increases. This, in turn, leads to an increase in the concentration of common traps in the forbidden zone of the composite, and a decrease in the free flight path of charge carriers.