Electrophysical Properties of Polymer-Nanocarbon Composite

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Composites based on polymer and conductive filler, including polyethylene-nanocarbonic system, have a positive temperature coefficient and high electrical conductivity at room temperature (up to 0.1 $(Om \cdot m)^{-1}$), which makes use of them as one of the promising materials for posistor heaters elements and self-renewing fuses (PolySwitch) [1-2].

In production of composites was used polyethylene with low-density (15803-020) or polypropylene. As a filler was used industrial carbon black marks N330 (according to ASTM D1765) with a particle size of 28-36 nm.

In the resulting nanocomposites with different volume fate of carbon (ρ_v) was investigated the temperature dependence of the electrical conductivity $\sigma(T)$, calculated temperature coefficient of resistance (α) and conductivity activation energy (ΔE).

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$\rho_{v,\ \%}$	σ_o, $Om^{-1} \cdot m^{-1}$	α, K^{-1}	ΔE, eV
5	0.00046	$2.9 \cdot 10^{-3}$	0.09
10	0.047	$4.7 \cdot 10^{-3}$	0.11
15	0.21	$9.7 \cdot 10^{-3}$	0.28
20	0.61	$7.4 \cdot 10^{-3}$	0.14
30	0.96	$1.9 \cdot 10^{-3}$	0.05

The conductivity increases with increasing volume fractions of nanocarbon. The temperature coefficient of resistance and activation energy first increases, the maximum observed in ρ_v = 15%, and then decreased. This can be explained by the formation of stable continuous conduction channels in the material contains large amounts of carbon.

1. M.F. Wartenberg, J.G. Lahlouh, Toth James. Conductive polymer compositions, and method of making the conductive polymer composition, US Patent, 19960319 (2003).
2. A.V. Degtyar'ov, A.S. Tonkoshkur, A.Yu. Lyashkov. Electrical properties of posistor composite materials based on polyethylene-graphite // Multidiscipline Modeling in Materials and Structures, VSP, 2006, v. 2, №4, p.p. 435-441(7).