Nanocomposites and nanomaterials

Parameters of charge transport in the nanosystems based on conducting polymers and carbon nanotubes

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Nanosystems based on conducting polymers doped by carbon nanoclusters (graphene, fullerene, carbon nanotubes) are promising materials for memory devices, plastic solar cells, and sensors. The charge transport in these systems is realized by non-linear topological excitations created in polymer chains - solitons or polarons and bipolarons in conjugated polymer chain. We studied the structure and temperature dependence of conductivity of conducting polymers - polyaniline (PANI), polytoluidine (PoTI) and poly-3,4-ethylene-dioxythiophene (PEDOT) doped by multiwalls carbon nanotubes (MWCNT) in the temperature interval of 273-403 K.

According to *X*-ray powder diffraction a process of polymer doping leads to increasing polymer crystalline level in result of formation the crystalline "domains" in the amorphous polymer matrix. Temperature dependence of specific volume resistance is follows by activation low and is linear in $\ln\rho$-$1/T$ coordinates at T = 293-393 K. Activation energy of charge transport varieties from 0.34 - 0.45 eV (undoped polymer) to 0.14 - 0.16 eV (doped by MWCNT).

Charge transport in low-dimensional polymer nanosystems may be considered in the frame of "domain" or "granular" model of conductivity. According to these performances in polymer there are existed the ordered areas (domain or crystallites) with high conductivity. Charge transport between these domains occurs by hopping mechanism across the low-conductive amorphous shells, which create the energetic barrier to conductivity. It may be expected that inside crystalline domains the significant inter-chain overlapping of wave function by all domain volume take a place. In result of doping the area of conductive domains (crystallites) is increased, for example, for PEDOT from 60 to 92 Å, degree of crystalline is twice higher.

Probably in these case incorporation of carbon nanotubes causes an improving the charge transport parameters due to structural ordering of polymer chains under influence of MWCNT also acting as conductive admixture, their percolation threshold is achieved already at MWCNT content near 1-2% (w).