Electrical conductivity of composite nanomaterial with carbon nanotubes

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Conducted are the experimental studies of the electrical conductivity σ of thick layers (thickness 10-80 μm) from composite nanomaterial (CNM), consisting of a gel for medical purposes based on carboxymethylcellulose (CMC) and multiwall carbon nanotubes (MWCNT) by "Taunit". Also studied is the dependence of σ of CNM from the intensity of infrared laser radiation (λ=970 nm).

In the 4% aqueous solution of CMC at t = 20 °C the value of σ is negligible ~ 0.5 S/m, its temperature dependence is positive with value $\alpha \sim 0.0024$ K^{-1} in the range t = (20-70)°C. After adding into the solution of CMC the MWCNTs with $c \leq 0.5$ wt. % the obtained suspension was carefully stirred, then put onto a strip of cotton cloth and exposed to laser irradiation.

In the dried layers of CMC+MWCNT the value of $\sigma \approx 1.5$ kS/m, $\alpha \sim 0.004$ K^{-1}, the percolation threshold corresponded to $c \sim 0.1$ wt.%. In the control samples, consisting of CMC and carbon black K-354 with $c \sim 0.5$ wt.% and prepared identically to CMC+MWCNT, obtained values of $\sigma \sim 0.06$ S/m and $\alpha \sim 0.004$ K^{-1}, and the percolation threshold was not observed.

Laser irradiation of the samples resulted in an increase of their relative conductivity $\sigma_w = (1-\sigma_T/\sigma)/W$, where σ is the conductivity before irradiation, σ_T – the conductivity after irradiation, W – the irradiation power density in [W/cm^2]. In layers of CMC+carbon black observed were higher values of σ_w = 25-35 %·cm^2/W, while for layers of CMC+MWCNT the value of σ_w = 3-5 %·cm^2/W. Photosensitivity of the studied samples is apparently due to the·bolometric effect.

High specific electrical conductivity, low percolation threshold, photosensitivity and biocompatibility allow us to consider the studied conducting composite nanomaterial as promising for biomedical and other applications.