Anizotropic reinforcement of polymeric composites properties by electromagnetic orientations of carbon nanotubes

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We consider methods of nanoparticles orientations in polymer matrix by various electromagnetic fields to produce composites with desirable properties of individual nanotubes as bulk properties. Analytical expressions are obtained for the purposeful choice of a method with taking into account properties of particles and field strengths. At present the following methods of particle orientation are under consideration by affecting them with 1) the external electric field, 2) the external magnetic field, 3) the nonuniform electric field of dielectrophoretic phenomena. Each method orients the particles according to their properties, which makes it possible to create desirable composites. The conditions for particle orientation with polarizability α and the magnetic moment p_b are: **1.** $E \geq \sqrt{4kT \ln|tg\theta| / \varepsilon_0 \alpha} / \theta$, where E is the electric field with strength, ε_0 is the electric constant, θ is the angle for the nanoparticle with respect to $\vec{E}$, T is the temperature of liquid polymer precursor; **2.** $B = (8\pi r^3 \eta / p_m t)\{\ln|tg\theta/2| - \ln|tg\theta_0/2|\}$, where B is magnetic field intensity, t is time of alignment, η is fluid matrix viscosity, r is radius of sphere equal particle volume, θ_0 and θ are initial and final angles between vectors $p_ь$ and B. Comparison of the considered methods allow us to conclude: 1) For using the electrostatic field the polarizability of particles must be not lower than $\alpha \approx 10^4$ nm^3; 2) For using the magnetic field the particles must have sufficiently high magnetic moments. This method allows to obtain films of relatively large size which are often in demand: 3) In using DEP it is difficult to obtain films larger than 1cm^2 in area. 4) Analytical formulas for fields intensities E and B helps to choose the method.