Magnetooptic Properties of Carbon Nanoparticles in Solutions

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The analysis of carbon nanoparticles mix that creates in arc-discharge process and in any other methods is a hard task. Except spherical fullerenes the other carbon nano-particles can been find in cathode deposit and nanotubes are most interesting subject among it.

We used a classic Cotton-Mouton method in molecular dilute solution [1] for investigation of optic and diamagnetic anisotropies of carbon nanoparticles.

The solutions was prepared by the sonication of carbon substances in water with surfactant or in organic solvents such as dimethylformamide, methylpyrrolidone in concentration range from 0.001 g/cm^3 to 0.0002 g/cm^3. The induced birefringence in magnetic field (MB) was measured by the high sensitivity compensation method [1] in magnetic field less than 6 kOe.

The carbon materials of different kinds were investigated. At first, it was dispersed cathode deposit, prepared at various discharge conditions. The MB dependence on magnetic field strength had complex character at investigated solutions and birefringence had negative sign. The results were compared with magnetic birefringence in graphite solutions and in black carbon solutions.

Except described substances, we measured MB in the nanotube-containing samples produced from the cathode deposit by using the special technology. The transmission electron microscope had shown that more then 5% of the sample consist from multi-wall nanotubes with the ratio length/diameter ≥ 5. Such carbon nanotubes in accordance with molecular structure must have a large optic and diamagnetic anisotropy, as well as a rigid rod-like polymer molecules with aromatic rings in main chain [2]. In this case the sign of MB must be positive [2], and such effect was experimentally detected in our work. It is coincide with results of experiments on orientation of multi-wall [3] and single-wall [4] carbone nanotubes in strong magnetic fields.

For cathode deposit with carbon nanotubes it was found that the experimental data can be described by Cotton-Mouton law $B=\Delta n/CH^2$ only at relatively high magnetic fields. Here B is Cotton-Mouton constant, Δn – birefringence, C – solution concentration, H – strength of magnetic field. At low magnetic field constant B became negative and it due to presence of graphite clusters in solution.

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References

1. V.Tsvetkov Rigid chain polymers. New York, Plenum Press, 1989.
2. V.Tsvetkov, G.Kudriavcev, E.Ryumtsev, V.Nikolaev, V.Kalmicova, A.Voloxina. //Dokladi Academii Nauk SSSR 1975, V.224, 398-401.
3. A.Fujiwara, H.Ootoshi, H.Suematsu, M.Yumura, K.Uchida, in: S.Fujiwara, et al.(Eds.), Super Carbon, MY, Tokyo, 1998.
4. D.Walters, M.Casavant, X.Qin, C.Huffman, P.Boul, L.Ericson, E.Haroz, M.O`Connell, K.Smith, D.Colbert, R.Smalley, Chem.Phys.Lett., 2001, V.338, 14-20.