Dispersion of multiwall carbon nanotubes in aqueous suspensions

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Carbon nanotubes (CNTs) are low density nanostructures built up of graphitic carbon, which exhibit remarkable mechanical properties (i.e. high strength and stiffness, elastic deformability), chemical stability, high electrical and thermal conductivity. These features of CNTs make them very promising and unique systems for new, already implemented, or potential applications in the material science, electronics, optics, biology and medicine [1].

The great obstacle to most applications of individual CNTs is their tendency to bundle up into ropes consisting of several tens of CNTs. These aggregation processes are governed by the strong intertube van der Waals attractions. The superior features of individual nanotubes in the aggregated state are significantly reduced, chemical manipulations limited and bioapplications infeasible. The preparation of aqueous suspensions of CNTs in the presence of appropriate dispersing agents is suggested to avoid these limitations. The interactions of dispersing agents such as surfactants or polysaccharides with carbon nanotubes lead to a separation of their bundles into individual nanotubes. In that way the unique properties of carbon nanotubes can be fully utilized [2 - 4].

The problem of stabilization of multiwall carbon nanotubes in water was the main goal of the study. Multiwall carbon nanotubes (MWCNTs) were suspended in water with addition the Nanosperse AQ surfactant (commercially dedicated) or natural polysaccharide - low methoxyl pectin (LMP). The morphology of studied systems was investigated by Transmission Electron Microscopy (TEM) (JEOL< JEM 1400, instrument with tungsten cathode operating at 120 kV). The chemical composition was evaluated via Energy-Dispersive X-ray Spectroscopy (EDS). The water dynamics in MWCNTs suspensions was analyzed by Nuclear Magnetic Relaxation Dispersion (NMRD) method [5]. The NMRD profiles showing spin-lattice relaxation T_1 as a function of Larmor frequency provide information of the nature of a surface nuclear relaxation processes taking place at water-MWCNTs interface.

Results of TEM studies have shown that exfoliation of MWCNTs appears due to addition of Nanosperse AQ (0.1% w/w) (Fig.1) and LMP (1% w/w) (Fig. 2). NMRD profiles exhibit the characteristic, logarithmic frequency dependence, terminated by plateau below a given cut-off frequency. With an increase of the MWCNTs concentration in aqueous suspensions the values of spin-lattice relaxation rates (R_1) are becoming longer. At the same concentration of MWCNTs more effective relaxation processes were found for suspensions containing the Nanosperse AQ than those containing the LMP. These results suggest the existence of two-dimensional surface diffusion of the proton species in close proximity to paramagnetic impurities in the surface of MWCNTs [6]. The presence of paramagnetic impurities in the studied systems was confirmed by the EDS experiment.

The experiment show that LMP is a good alternative for commercially dedicated dispersing agent, Nanosperse AQ, and because of its low toxicity, more usable in bioapplications.

References

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Figures

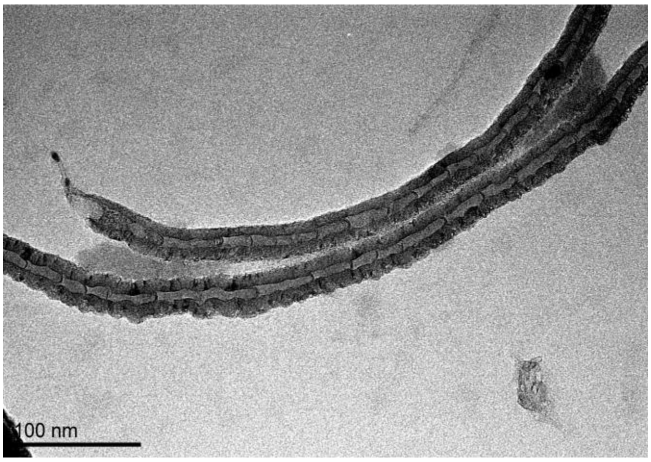

Fig. 1 TEM micrograph of MWCNTs suspended in water with 0.1% w/w Nanosperse AQ

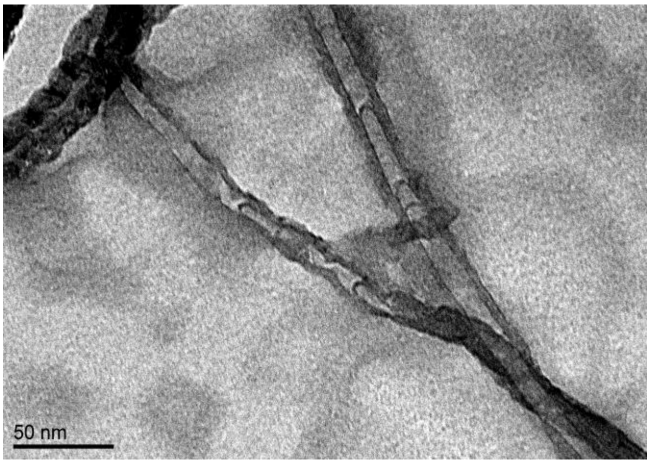

Fig. 2 Cryo TEM micrograph of MWCNTs suspended in water with 1% w/w LMP