EFFECT OF SURFACTANT ADDITION ON THE MWNT SUSPENZIONS STABILITY IN ORGANIC SOLVENTS

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ABSTRACT

It is shown that multi-walled carbon nanotubes (MWNT) form stable suspensions in isopropanol solvent as a result of influence of ultra-sound in the weight range of concentrations from 0.0001% to 1% by weight. Nonionic surfactant Triton X-165 affects the microstructure of the MWNT aggregates in isopropanol, a small amount of surfactant increase the intervals between the aggregates and accelerate the sedimentation process. MWNT suspension in and toluene shows unstable behavior, their total precipitation time is less than 10^4 sec. Addition of 0.4% Triton X-165 to suspension of MWNT in p-xylene leads to its stabilization. Also, addition of 0.6% Triton X-165 leads to partial stabilization of suspensions of MWNT in toluene.

Key words: multi-walled carbon nanotubes, surfactant, Triton X-165, sedimentation, isopropyl alcohol, p-xylene, toluene

INTRODUCTION

Dispersion of MWNT are used in the production of composite materials, films, filters, conductive coatings and fillers [1]. The creation of suspensions is one of ways to produce MWNT dispersions. The stability of MWNT in liquids and their densities, viscosities, polarities and other physical and chemical properties are reflected in the most important characteristics of the final product [2]. Organic liquids often wet carbon materials better than water-based suspensions; therefore suspensions of MWNT in many organic solvents are sufficiently stable [3]. Furthermore, the addition of surfactants can contribute to dispersions stabilities [4].

METHODS OF SAMPLE PREPARATION AND ANALYSIS

MWNT are produced by "Spetsmash", Ukraine. The length of the nanotubes 5–10 microns, average diameter is approximately equal to 18 nm, the average number of layers - 14, the distance between the layers - 0.34 nm. Dispersive medium is isopropyl alcohol (chemically pure, "Alfarus", Kiev).

The dispersion of MWNT in the suspension produced by ultrasonic disperser UZDN-2T (Russia), the power of 450 W, frequency 22 kHz. It was pre-

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pared a few samples of suspensions with different mass concentrations of MWNT, from C=0.0001% to C=1%.

The nonionic surfactant Triton X-165 (Sigma-Aldrich) was used for determining the effect of surfactants on stability of the suspension. Surfactant was added to the suspension during ultrasonic treatment.

Optical transmission of dispersion was studied by photoelectric colorimeter KFK-2MP (LOMO, Russia). Electrical conductivity was measured using the multimeter LCR-819 (Instek, Taiwan) with alternating current frequency of 1 kHz and an effective voltage 0.25 V.

The sample in the cell with optical path length 10 mm was photographed through the eyepiece of an optical microscope Biolar ZM-50 (PZO, Poland) with an increase 125x with camera Canon A580 (Taiwan). The studies were conducted at a temperature of 298 K.

RESULTS AND DISCUSSION

Suspensions of MWNT in isopropanol. It is shown that MWNT can form a stable suspension in isopropanol a result of influence of ultra-sound irradiation in the investigated concentration range. The aggregates of nanotubes are visible with an optical microscope in a suspension starting from concentration of about 0.01%. Bridges between the aggregates appear when the concentration reaches 0.1% by weight. The rapid growth of electrical conductivity to a value of about 10^{-4} $(\Omega \cdot M)^{-1}$ occurs at this concentration.

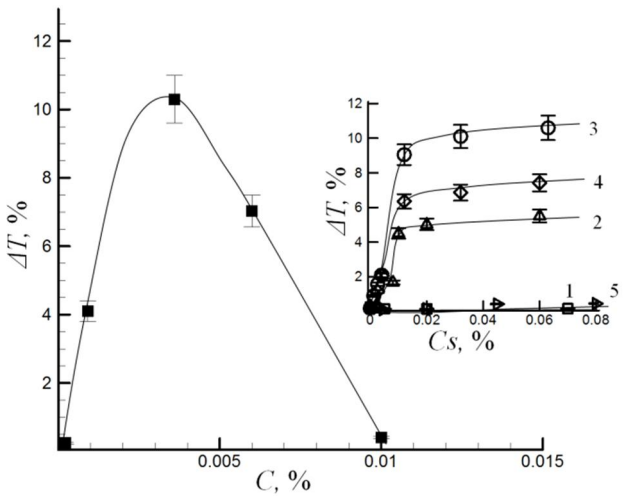

Fig. 1 – The change of optical transmission of suspension (ΔT) during 6000 sec from the end of ultrasonic treatment with the surfactant concentration 0.04% in dependence of the concentration of MWNT (C). Inset: dependence of the optical transmission ΔT suspension of the surfactant concentration (Cs) for different mass concentrations of MWNT C: 1) C = 0.00023%; 2) C = 0,00092%; 3) C = 0,0036%; 4) C = 0,006%; 5) C = 0,01%

Adding a surfactant Triton X-165 results in a slight reduction and fragmentation of aggregates of nanotubes, but also speeds up the sedimentation process in the suspension. Time of deposition decreases with increase the surfactant concentration.

MWNT suspension in p-xylene. MWNT suspension in p-xylene is not stable, complete sedimentation time is c.a. 4000 sec, regardless on concentration of MWNT. Addition a surfactant strongly reduces the initial transmission and decelerate sedimentation processes. Surfactant suspension becomes stable when the mass fraction becomes of about 0.4%.

Addition the surfactant does not affect evidently the microstructure of aggregates MWNT. This fact entails the conclusion that the surfactant prevents sedimentation process in the suspension.

Suspensions of MWNT in toluene. Suspensions of MWNT in toluene are instable, the complete sedimentation finishes for 6000 sec. Sedimentation MWNT in toluene occurs in one and a half times longer than in p-xylene.

Addition a surfactant slightly stabilizes the suspension MWNT in toluene, but it is not such effective as in p-xylene. Optical transmission of suspension after addition the surfactant grows slowly. The microstructure of samples of the suspension, containing the surfactant does not differ from the samples which do not contain surfactant. The greatest effect of addition of surfactant observed when it`s mass fraction becomes of about 0.6%.

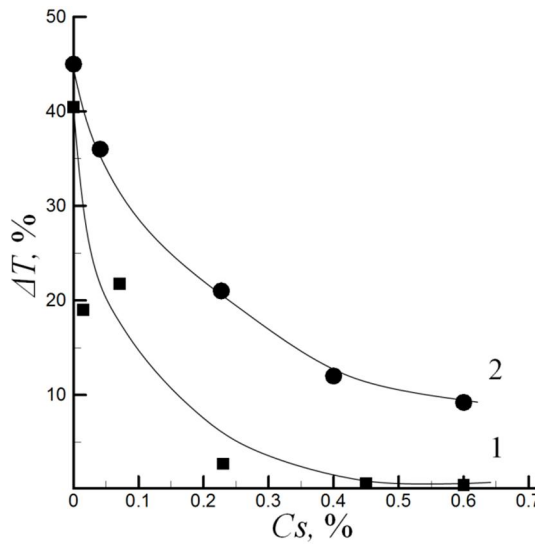

Fig. 2 – The change of optical transmission of suspension (ΔT) during 6000 sec of the end of ultrasonic treatment in p-xylene (1) and toluene (2) in dependence of the surfactant concentration (Cs). Concentration of MWNT in suspensions is 0.0015%

CONCLUSIONS

Suspensions of multi-layer carbon nanotubes in isopropanol in the range of concentrations by weight of 0.0006% to 1% form stable suspensions without any addition of surfactants under influence ultrasound radiation. MWNT suspensions in p-xylene and toluene are unstable, and their total precipitation time is less than 10^4 sec.

Addition of 0.4% Triton X-165 to suspension of MWNT in p-xylene leads to its stabilization. Also, addition of 0.6% Triton X-165 leads to partial stabilization of suspensions of MWNT in toluene. But addition of Triton X-165 into the suspension on the basis of isopropanol leads to its rapid sedimentation. Nonionic surfactant Triton X165 reduces slightly the size of aggregates of MWNT in isopropyl alcohol.

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