PERSPECTIVE COMPOSITE MATERIALS FOR GENERAL AND SPECIAL MECHANICAL ENGINEERING

Ph.D. Khantimerov S.M.[1,2], M.Sc. Khantimerova Yu.M.[2], M.Sc. Garipov R.R.[1], Dr. Suleimanov N.M.[1]
Zavoisky Physical-Technical Institute, FRC Kazan Scientific Center of RAS, Russia [1]
New Structures & Technologies, LLC [2]

khantim@mail.ru

Abstract: *The work considers the use of carbon nanotubes to enhance the functional characteristics of polymer materials. The results on studies of the electrophysical properties of polymers doped with carbon nanotubes are presented and prospects for the use of such materials are discussed.*

Keywords: ELECTROCONDUCTIVE POLYMER COMPOSITES, DOPING, CARBON NANOTUBES, MODIFICATION

1. Introduction

The production of new equipment, special-purpose constructions with a high functional properties requires the development of new materials or the improvement of traditionally used ones. An effective solution ща these problems is based on the development of new composite materials doped by micro- and nanostructures. Carbon nanotubes (CNTs), which have a complex of unique physical-chemical properties, can be considered as one of the most promising types of modifiers [1]. Such CNT-based fillers make it possible to vary both the strength characteristics of polymers and in a wide range the electrical conductivity of the polymer matrix [2, 3]. This greatly expands the possible applications of composite materials. Due to their electronic properties and high aspect ratio (the ratio of length to diameter) of carbon nanotubes, their addition to the polymer matrix in an amount of 0.2% causes an increase in the electrical conductivity of the resulting composite by 8-10 orders of magnitude. In this case, the percolation nature of the conductivity of the material appears, according to which, with a small content of the conductive additive, charge transfer occurs through a small number of conducting channels formed upon the contact of the additive particles.

Despite of all the attractiveness of using carbon nanostructures to create promising composites, there is a number of problems that prevent their wide application. One of them is the problem of obtaining nanocomposites based on carbon nanotubes with their uniform distribution in the matrix and the need for the formation of covalent bonds between the surface of nanotubes and polymer. Without further modification, CNTs tend to form agglomerates. In addition, the graphene surface of a nanotube can form only weak van der Waals bonds with a polymer matrix, which inhibits the achievement of useful properties in polymer composite materials. In order to better disperse the modifier in the matrix, and also to form covalent bonds between the matrix and the nanoparticles, the functionalization of nanotubes is used [4, 5].

It should be noted that the final properties of the composite material doped with carbon nanotubes depend significantly on a number of factors. A key element in creating composites with given properties is a fundamental understanding of the mechanism of composites formation in the interaction of constituent components, basic and alloying. In the case of CNTs used as the doping component, the determining factor is their morphology, electronic structure, concentration, surface state, in particular, the presence of functional groups interacting with the matrix medium.

The purpose of this paper is to study the concentration dependence of electrical conductivity of a composite material based on ABS-plastic and functionalized carbon nanotubes.

2. Materials and Methods

As carbon nanotubes conical carbon nanotubes were used. Conical carbon nanotubes were grown by pyrolysis of granular polyethylene. These nanotubes are several microns in length, with outer diameters ranging between 40 and 50 nm and inner channels varying between 9 and 20 nm. The fringe spacing is 0.34 nm. Such nanotubes are characterized by a large number of broken chemical bonds necessary for the attachment of external molecular groups.

An ABS-1035, produced by PJS company Kazanorgsintez (Kazan, Russia) was used as polymer matrix.

For the production of composite samples based on ABS doped by carbon nanotubes, a specially developed technique including thermochemical and ultrasonic treatment was used [6]. A series of ABS/CNTs composites with varied amounts of CNTs (0.125, 0.25, 0.5, 1 wt.%) were prepared.

The concentration dependence of electrical conductivity of a composite material based on ABS and functionalized carbon nanotubes was measured by using four-probe van der Pauw method at ambient temperature.

3. Results and Discussion

Figure 1 shows the samples of a polymeric composite material based on ABS and functionalized carbon nanotubes with different concentrations. The concentration dependence of electrical conductivity of ABS/CNTs composites is presented on Fig.2.

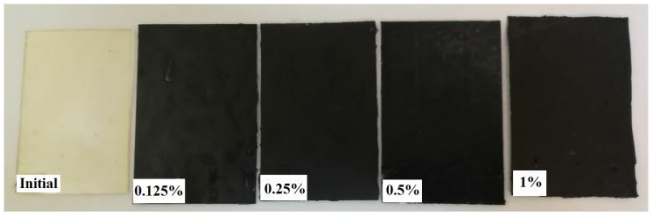

Fig.1 *Samples of a polymeric composite material based on ABS and functionalized carbon nanotubes with different concentrations.*

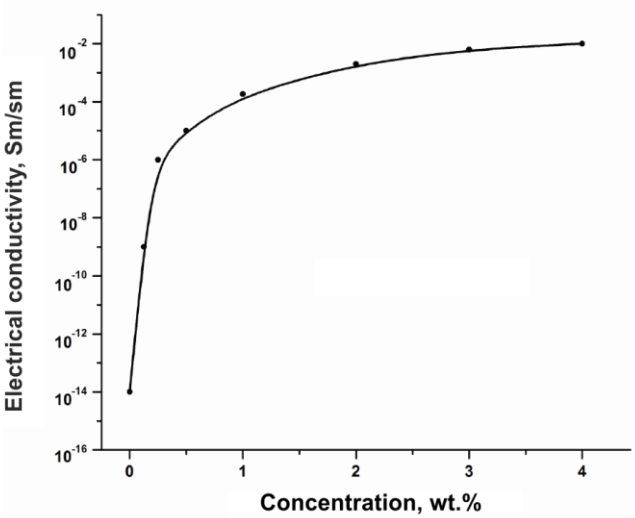

Fig.2 Concentration dependence of electrical conductivity of ABS/CNTs composites.

It can be seen from Fig. 2 that the increase in the electrical conductivity is nonmonotonic: its sharpest change was observed in a narrow range of filler concentrations, which allows to consider a dielectric-metal transition or a percolation transition when the amount of the conducting particles in a material equals to the percolation threshold.

Thus, in this paper the manufacturing of a composite material with controlled electrical conductivity based on ABS and carbon nanotubes is shown. The developed electrically conductive composite material based on polymers and CNTs can be used, for example, in the manufacturing of conductive pastes and adhesives, as electrically conductive liners and plates in modern composite machine parts in general and special engineering.

4. Acknowledgements

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5. References

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