

Nanocomposites and nanomaterials

Laser desorption/ionization mass spectrometric study of carbon nanotube-polyoxymethylene nanocomposite

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Development of new methods of production and study of functional nanocomposites of carbon nanotubes (CNT) and organic molecules is an urgent task of modern nanotechnology. In the present work we propose a method of manufacturing of CNT composites with polyoxymethylene (POM) oligomers with inclusion of small biologically active molecules: arginine and histidine amino acids, cytosine nitrogen base, and methylene blue dye, and report the results of characterization of these nanomaterials by means of laser desorption/ionization (LDI) mass spectrometry. The mixtures of the components of the composite to be were treated by ultrasound in 40% formaldehyde and cooled in the vapours of liquid nitrogen. It is assumed that POM_n oligomers formed by low temperature polymerization of formaldehyde cover the CNT surface; the biomolecules are expected to be trapped between the polymeric chains. The novelty of the method proposed was in application of freeze-dry cryotechnology to produce solid waterless material. Thus produced solid nanocomposites were analyzed by LDI mass spectrometry. Two sets of cationized POM_n oligomers were recorded: HO-(CH₂)_n-H•Na⁺ and HO-(CH₂)_n-H•K⁺ (n=4-20). Observation of such sets confirmed formation and stabilization of the POM polymer in the composite material. As to small organic dopants, the peaks corresponding to heterocyclic compounds – the protonated nitrogen base and the dye cation – were recorded, while signals of amino acids were absent in the LDI mass spectra of the corresponding composites. Molecular dynamics simulation of CNT-POM_n complexes in vacuum and aqueous media had shown relatively strong adsorption of the oligomers at the CNT surface. An interesting effect of penetration of the POM chain into the interior of a single walled CNT in water was observed in computer experiment. Formation of such complexes may contribute to the stabilization of the nanocomposite.

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