Preparation of polymer – carbon nanotubes composites using supercritical antisolvent precipitation and rapid expansion of supercritical suspensions

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Polymer - carbon nanotube (CNTs) composites have been a subject of a very active research over the last decade. Unique mechanical and electrical properties of such composites give a possibility to their use in different areas: in aerospace industry, as deformation sensors, gas detectors, desalination membranes etc. The main problem, which occurs in the preparation of these composites, is agglomeration of CNTs. Due to long times required for transition from liquid phase to solid conventional techniques such as solution processing, melt blending and *in situ* polymerization do not give a chance to avoid agglomeration. This leads to inhomogeneous distribution of CNTs in the polymer matrix and deterioration of mechanical and electrical properties of composites. The aim of this work was twofold: 1) to develop an effective dispersion of nanotubes prior to embedding them into polymer matrix by Rapid Expansion of Supercritical Solutions (RESS) method and 2) to develop a agglomeration-free method for polymer - CNT composites formation by supercritical antisolvent (SAS) precipitation. In the first part of this work optimization of different conditions (pressure, temperature, type of supercritical fluid) of CNTs RESS treatment is described. It is shown that the use of supercritical nitrogen is more effective, than carbon dioxide. The conductivity of RESS-processed CNTs composites was several orders of magnitude higher than those synthesized without additional treatment. The use of RESS technology also gives a possibility to obtain composites with a percolation threshold of ca. 0,01% which is 50 times lower when compared with unprocessed CNTs composites. The second part of work is devoted to SAS preparation of polycarbonate (PC), polymethylmethacrylate (PMMA) and polyurethane composites with homogeneous CNTs distribution in polymer matrix. Typical SEM image of polyurethane – CNTs composite obtained via SAS is demonstrated in fig. 1. Moreover, it is shown that introduction of CNTs by SAS leads to significant improvement of polymers mechanical properties. Tensile strength and total elongation for obtained composites is higher in 1.5 - 1.9 and 2 – 6 times compared to initial polymers. The use of RESS-treated CNTs leads to additional growth of mechanical properties of composites (approximately 20%). Mechanical characteristics of PC and PMMA composites precipitated by SAS were also better compared with those obtained by conventional solution processing method.

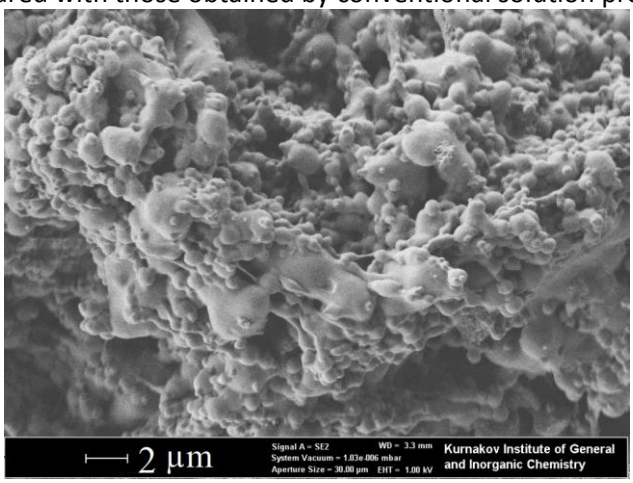

Fig. 1. SEM image of polyurethane - CNT composite powder obtained by SAS. CNTs were treated via RESS

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