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Bulk microstructure of nanocomposites studied by the impulse acoustic microscopy technique

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The idea of nanocomposites implies that substantial changes in composite properties are realized at minimal content of nanofiller. The changes stem from formation of extensive bulk networks of contacting nanoparticles and great value of contact interface of nanoparticles with polymer matrix. Highly dense distribution of contact interfaces results in restructuring polymer matrix and altering properties of the composite material. Therefore, nanoforms with big aspect ratios – nanotubes, nanoplatelets, nanoflakes; are used as filler to provide ramified interparticle contacts. topology of nanofiller distribution is of great importance for nanocomposite properties. Uniform distribution of nanoparticles is needed to provide optimum conditions for forming the continuous clusters of nanoparticles, and for maximal influence of nanofiller on composite properties.

In the paper the bulk mesostructure and local mechanical properties of epoxy nanocomposites with diverse carbon nanoforms – particles of exfoliated graphite (EG), graphite nanoplatelets (GNP), carbon nanoflakes (CNF), multiwall carbon nanotubes (MWCNT); have been studied by methods of the impulse acoustic microscopy (AM). The impulse AM is one of the key techniques that provide direct data on bulk microstructure and local bulk properties of a composite matter. The technique. In comparison with the alternative technique - X-ray microtomography; the impulse acoustic microscopy is characterized by combination of high efficiency, technical primality and availability.

The impulse AM has been applied for studies of 3D microstructure and micron resolution measuring local values of sonic velocities and elastic modules in carbon nanocomposites prepared by conventional technologies as well as with using vacuum mixing. The technique has shown.

Technique of pulse AM has been shown the micronon-uniform distribution of a carbon nanofiller over the nanocomposite bulk. The basic tendency of carbon nanoparticles to local clusterization and to formation of fractal micron-sized clusters containing entrapped air is shown. Nanoparticle aggregates with air content are well visible on layer-by-layer acoustic images of bulk microstructure for all types of nanocarbon composites at arbitrary depth inside their bulk. Results of the executed local elastic measurements demonstrate uniformity of bulk elastic properties and their weak dependence on type and content of carbon nanofiller. Comparison of the images of bulk microstructure produced by techniques of the impulse acoustic microscopy and x-ray microtomography certifies high informational content of acoustic images.