Nanocomposites and nanomaterials

Role of self-organized low supersaturations in carbon nanofibres formation

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The majority of technological approaches related to synthesis of carbon nanofibres including nanotubes is based on CVD, plasma arc and mixed PVD and CVD technologies. The fact that carbon nanoobjects produced by different technologies are similar indicates that there should be similar thermodynamical conditions of condensation. We have suggested all techniques of carbon nanofibres formation to be based on using low time-invariable relative supersaturations of deposited vapours, i.e. on proximity to thermodynamical equilibrium.

In case of low deviation from equilibrium condensation kinetics differs considerably from that of the far-from-equilibrium case. Thus, in the former case deposited atoms are fixed in atom-by-atom way on active growth centres with binding energy higher than a certain critical value. This can result in atom-by-atom assembly of carbon nanofibres by realizing the strongest sp^2-hybridized bonds. These structures are usually synthesized at presence of an active medium, such as plasma, reactive gas or reactive gas plasma. Thus, stimulated approaching to equilibrium occurs during deposition by means of lowering of adatom desorbtion energy to an effective value and increase in growth surface temperature.

Analyzing mathematical model created in the given work, it has been shown that a plasma-arc device which was used to produce carbon nanotubes by S. Iijima [1] was based on self-organization of low supersaturation. The necessity of having self-organized supersaturation has been confirmed by us experimentally [2] using special sputtering device operating at glow discharge in magnetic field. Comparing different deposition techniques we conclude that the systems of self-organized supersaturations have higher stability of deposition process. Also signs of the two following interdependent self-organizations have been found: dissipative self-organization of low supersaturations and conservative self-organization of nanofibres.

1. *Iijima S.* Helical microtubules of graphitic carbon // Nature.-1991.-**354**, N 6348.-P. 56-58.
2. *Perekrestov V. I., Latyshev V. M., Kornyushchenko A. S., Davidenko T. A.* Production of Carbon Nanostructures under Stationary Quasi-Equilibrium Condensation during Magnetron Sputtering // Instrum. Exp. Tech.-2013.-**56**, N.6.-P. 736-740.