Longer carbon nanotubes by controlled catalytic growth in the presence of water vapor

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The growth of longer carbon nanotubes (CNT) for construction nanomaterials is one of the major challenges of CNT research [1]. It has been demonstrated that long contact time is a powerful tool and obvious precondition for longer CNT [2]. However it is well known since 1970s that longer contact time may lead to stronger radial growth [3]. The competition between axial and radial growth at longer contact time usually results in the production of microfibers other than CNT. The introduction of oxygen-containing compounds may be used as a means of controlling CNT structure and/or suppressing radial growth.

The purpose of the present work was to study possibilities of water vapor control over growth of longer CNT from ethylene-based feedstock. SEM, TEM and Raman spectroscopy were used for the resulting deposit characterization. The synthesis was carried out at the temperature of up to 1150°C. H_2 was used as a carrier gas at the flow rate of 600 ml/min. The reactor allowed contact time up to 1 min.

It was found that H_2O/C ratio in the range from 0.5/1 to 2.0/1 influences both yield and the structure of CNT. It is shown that the yield of centimeter-long CNT can be maximized at an optimum H_2O/C ratio.

A mechanism for the water-assisted growth of CNT is proposed and discussed.

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