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Low- and High-Temperature Methods of CNTs Synthesis for Medicine

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Abstract : One of the most promising area for carbon nanotubes (CNTs) application is medicine. One of the most devastating diseases is cancer. Carbon nanotubes may be used as carriers of a slowly released drug. It is possible to use of electromagnetic waves to destroy cancer cells by the carbon nanotubes (CNTs). In our research we focused on thermal ablation by ferromagnetic carbon nanotubes (Fe-CNTs). In the cancer cell hyperthermia functionalized carbon nanotubes are exposed to radio frequency electromagnetic field. Properly functionalized Fe-CNTs join the cancer cells. Heat generated in nanoparticles connected to nanotubes warm up nanotubes and then the target tissue. When the temperature in tumor tissue exceeds 316 K the necrosis of cancer cells may be observed. Several techniques can be used for Fe-CNTs synthesis. In our work, we use high-temperature methods where arc-discharge is applied. Low-temperature systems are microwave plasma with assisted chemical vapor deposition (MPCVD) and hybrid physical-chemical vapor deposition (HPCVD). In the arc discharge system, the plasma reactor works with a pressure of He up to 0,5 atm. The electric arc burns between two graphite rods. Vapors of carbon move from the anode, through a short arc column and forms CNTs which can be collected either from the reactor walls or cathode deposit. This method is suitable for the production of multi-wall and single-wall CNTs. A disadvantage of high-temperature methods is a low purification, short length, random size and multi-directional distribution. In MPCVD system plasma is generated in waveguide connected to the microwave generator. Then containing carbon and ferromagnetic elements plasma flux go to the quartz tube. The additional resistance heating can be applied to increase the reaction effectiveness and efficiency. CNTs nucleation occurs on the quartz tube walls. It is also possible to use substrates to improve carbon nanotubes growth. HPCVD system involves both chemical decomposition of carbon containing gases and vaporization of a solid or liquid source of catalyst. In this system, a tube furnace is applied. A mixture of working and carbon-containing gases go through the quartz tube placed inside the furnace. As a catalyst ferrocene vapors can be used. Fe-CNTs may be collected then either from the quartz tube walls or on the substrates. Low-temperature methods are characterized by higher purity product. Moreover, carbon nanotubes from tested CVD systems were partially filled with the iron. Regardless of the method of Fe-CNTs synthesis the final product always needs to be purified for applications in medicine. The simplest method of purification is an oxidation of the amorphous carbon. Carbon nanotubes dedicated for cancer cell thermal ablation need to be additionally treated by acids for defects amplification on the CNTs surface what facilitates biofunctionalization. Application of ferromagnetic nanotubes for cancer treatment is a promising method of fighting with cancer for the next decade. Acknowledgment: The research work has been financed from the budget of science as a research project No. PBS2/A5/31/2013

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