Living cells and carbon nanotube interfaces for bio-nano-electronic devices

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Carbon nanotubes are one of promising nanotechnology products and since their structure is geometrically close to collagen - the main protein of the mammal connective tissue, they can be used in biological engineering as a scaffold material for tissue regeneration. Unique electronic properties, high mechanical strength, excellent flexibility and large specific surface area of nanotubes make them suitable for creating novel biocompatible composite materials for tissue engineering.

The main steps of cell-nanotube device production are the next: (1) nanotube composite film preparation, (2) biocompatibility test, (3) investigation of electric field effect on cell proliferation on nanotube films and (4) organization of nerve cell interaction with nanotube.

The method for making transparent, conductive and biocompatible CNT-BSA films has been developed [1]. We have proposed a novel method of CNT films/electrodes fabrication with using BSA as a surfactant and the rod-coating technique for films deposition. It was demonstrated, that the CNT films, obtained by the method, achieve 90% transparency with resistivity of about 45 kOhms/□.

The effects of single-walled and multi-walled carbon nanotubes on proliferative activity and viability of human embryo fibroblasts (HEF) and glioblastoma cells were studied [2]. Low cytotoxic activity of single-walled carbon tubes was demonstrated. Possible mechanisms of nanotube effects on cell growth are discussed. We investigated the proliferation of HEF cells, which were subjected to electrical stimulation when cultured on carbon nanotube film surface [3]. A weak increase in proliferation is demonstrated at stimulating field pulses up to 100 mV. It is assumed that the transport mechanism accompanied by higher synthesis of proteins and their polymerization may increase proliferative activity at low voltages (fig. 1).

We investigated neuroblastoma cells cultivated on single-walled carbon nanotubes networks made by two methods: CVD and drop coating. The complex analysis of grown cells made by atomic force, electron microscopy and Raman spectroscopy was carried out and the effect of nanotube growth process on proliferation factor was investigated (fig. 2) [4]. It is shown that despite of a weak decrease in proliferation, cell morphology remains unchanged and no physical or chemical interaction between carbon nanotubes and cells is observed.

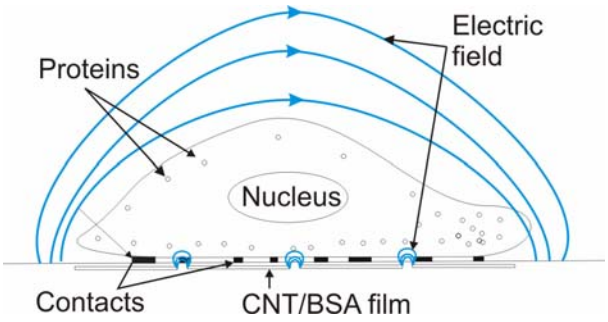

Fig. 1 Schematic drawing of HEF cell on nanotubes based film in electric field.

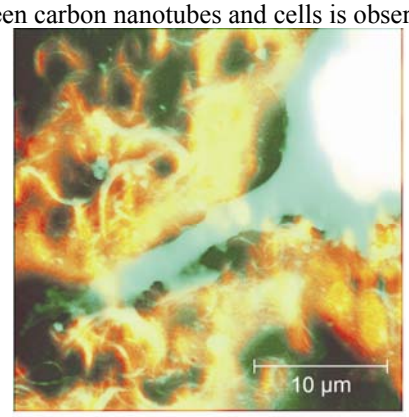

Fig. 2 Artistic combination of AFM and microRaman image of nerve cell and nanotube interaction.

The results of the given investigation may be used for flexible electrodes development on the basis of CNT for registration of electric activity, directed growth of neurons, stimulation and regeneration of tissues through CNT and creating neural-prostheses.

References

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