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Micro-Spot Atmospheric Pressure Plasma Production for the Biomedical Applications

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We are currently conducting studies on culturing and biocompatibility assessment of various cells such as neural stem cells and induced pluripotent stem cells(IPS cells) on carbon nanotube (CNT), on nerve regeneration electrodes, and on silicon wafers with a focus on developing nerve integrated CNT based bio devices for interfacing with living organisms, in order to develop brain-machine interfaces (BMI). In addition, we are carried out the chemical modification of carbon nanotube (mainly SWCNTs) -based bio-nanosensors by the plasma ion irradiation (plasma activation) method, and provide a characteristic evaluation of a bio-nanosensor using bovine serum albumin (BSA)/anti-BSA binding and oligonucleotide hybridization. On the other hand, the researches in the case of "novel plasma" have been widely conducted in the fields of chemistry, solid physics, and nanomaterial science. From the above-mentioned background, we are conducting basic experiments on direct irradiation of body tissues and cells using a micro-spot atmospheric pressure plasma source.

The device is a coaxial structure having a tungsten wire installed inside a glass capillary, and a grounded ring electrode wrapped on the outside. The conditions of plasma generation are as follows: applied voltage: 5-9 kV, frequency: 1-3 kHz, helium (He) gas flow: 1-1.5 L/min, and plasma irradiation time: 1-300 sec. The experiment was conducted by preparing a culture medium containing mouse fibroblasts (NIH3T3) on a culture dish. A culture dish irradiated with plasma was introduced into a CO_2-incubator. The small animals used in the experiment involving plasma irradiation into living tissue were rat, rabbit, and pick and are deeply anesthetized with the gas anesthesia.

According to the dependency of cell numbers against the plasma irradiation time, when only He gas was flowed, the growth of cells was inhibited as the floatation of cells caused by gas agitation inside

the culture was promoted. On the other hand, there was no floatation of cells and healthy growth was observed when plasma was irradiated. Furthermore, in an experiment testing the effects of plasma irradiation on rats that were artificially given burn wounds, no evidence of electric shock injuries was found in the irradiated areas. In fact, the observed evidence of healing and improvements of the burn wounds suggested the presence of healing effects due to the growth factors in the tissues. Therefore, it appears that the interaction due to ion/radicalcollisions causes a substantial effect on the proliferation of growth factors such as epidermal growth factor (EGF), nerve growth factor (NGF), and transforming growth factor (TGF) that are present in the cells.

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