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Plasma-on-Chip: A microdevice for irradiating single cells with non-thermal atmospheric pressure plasma

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Since non-thermal atmospheric pressure plasma (NTAPP) was first applied in biomedical research, excellent results have been reported leading to many technical innovations. For instance, plasma treatment reduced bacteria on wounds and healed dermatosis. In a laboratory experiment, cancer cells were successfully inactivated. Many researchers have been working on elucidating NTAPP-cells interactions. However, details of the interactions have not been clear. What is actually happening inside the cells?

To answer the question, we have developed a microdevice referred to as the *Plasma-on-Chip* with which plasma irradiation at single-cell level can be possible as shown in Fig. 1 [1, 2]. The device consists of a mirowell for cell culture and a micro plasma source for generating reactive oxygen/nitrogen species (RONS) [3] and other stimuli. In between, the microwell has a small through-hole at the bottom. When cell-containing liquid medium is put in a microwell, liquid is held there without leakage because of the surface tension. When a NTAPP is generated at the backside of the microwell, the RONS and other stimuli are delivered into the liquid via the gas-liquid interface formed at the through-hole. The *Plasma-on-Chip* enables direct plasma irradiation to cultured cells.

Using the *Plasma-on-Chip*, we conducted plasma irradiation to murine fibroblast cells L929 and NIH3T3, green algae *Chlorella*, and *Saccharomyces cerevisiae*. By analyzing gene expression in the irradiated cells, details of plasma effects can be revealed [4].

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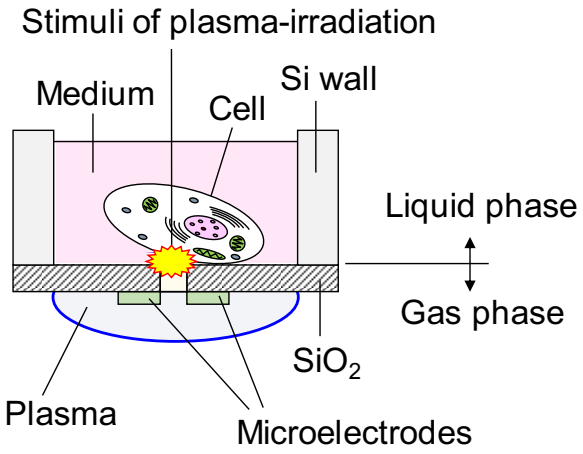

Fig. 1: Cross sectional image of *Plasma-on-Chip* device. A microwell is fabricated on a Si chip. The microwell bottom has a through-hole. When a liquid medium containing a cell is put in the microwell, surface tension forms gas-liquid interface at the through-hole holding the liquid medium inside. At the backside of the microwell, micro plasma source is fabricated. When a plasma is generated, stimuli of the plasma are delivered directly to the cell via the gas-liquid interface.

References

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