Plasma-on-Chip for Treatment of Individual Cells Cultured in Medium

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The plasma medicine is one of the hot research areas of using low-temperature plasmas at atmosphere [1]. We have been developing a MEMS device for irradiating cells cultured in microwells with low-temperature atmospheric pressure plasma. The MEMS device was named "plasma-on-chip" as shown in Fig.1 [1]. The plasma-on-chip will be used to activate or inactivate cell functions through plasma irradiation. Here, we report the improvement of the device and demonstration of plasma treatment against biological samples.

1. Improving the durability of plasma-on-chip

When plasma-on-chip was operated, the micro gap-electrodes for plasma generation were frequently damaged by Joule heating. To make the micro gap-electrodes more durable, the dielectric barrier discharge (DBD) method was used. Simple gap-electrode structures (gap width: 10 mm) were coated with permanent photoresist film (TMMR S2000, Tokyo Ohka Kogyo) and tested. Thicker dielectric film layer provides more protection but higher voltage is required to generate a plasma. Film thickness was optimized and with a 6.4 mm-thick-film, plasma ignition occurred at bias voltage of 1200 V and 1 kHz. In the presence of the film, electrode damage was reduced. However, when 100 mm-gap electrodes were covered with the films, plasma ignition hardly occurred. Design of gap-electrodes should be improved.

2. Operating plasma-on-chip for biological samples

We used yeast cells which can be cultured easily under ambient conditions and suitable for demonstrations. Plasma-on-chip was operated under the same condition used for the experiments of *Chlorella* cells [2]. For the Chlorella cells, the plasma treatment seemed to inactivate the *Chlorella* cells. For the yeast cells, no significant change was observed.

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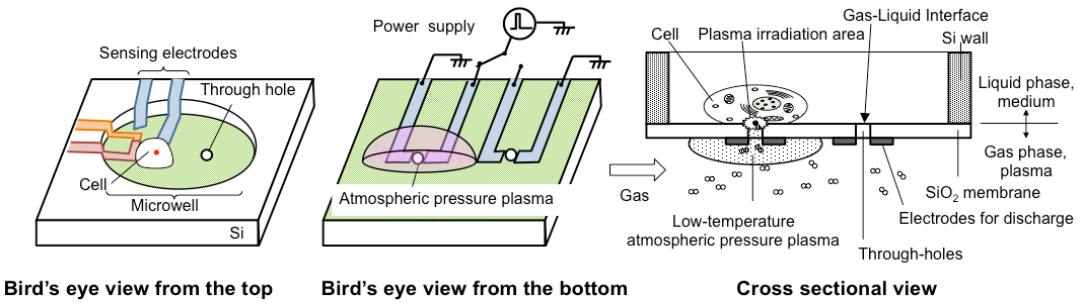

Fig. 1. Schematic drawings of plasma-on-chip.

[1] Kong et al. New J. Phys. 11 (2009) 115012. [2] Chang et al., JSAP spring meeting 2015, 12a-P10-8.