

# Observation of Skin Changes by Atmospheric Plasma Jet Irradiation

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## INTRODUCTION

Medical application using atmospheric plasma have been studied such as sterilization, blood coagulation and a wide range of the other applications [1, 2]. Radicals, active species and so on which are generated by atmospheric plasma could be beneficial for use in various medical application. However, the specific mechanism of the biomedical effects are not clearly understood. In addition, a less invasive treatment for human body is required in the medical applications.

Atmospheric plasma jet has been investigated as a plasma source for biomedical application recently [3]. Especially, atmospheric plasma jet using argon as a process gas was employed for blood coagulation and cauterizing tumors. If atmospheric plasma jet irradiates living matter directly, it is concerned that the irradiation may have a bad influence on the living matter.

In this study, the changes by irradiating atmospheric plasma jet on a rat skin was investigated.

## METHODS

### (1) Experimental setup

Figure 1 shows the experimental setup. An electrode for generating atmospheric plasma jet consisted in a glass tube, a tungsten wire and aluminum tape. The tungsten wire was energized by a neon transformer and the aluminum tape was grounded. The process gas was fed from a gas cylinder to the electrode.

Figure 2 shows the discharge voltage and current waveforms. Figure 3 shows the image of the discharge. The atmospheric plasma jet irradiated the wister rat skin on a stage with a distance of 1 mm between a tip of the electrode and the rat skin surface.

Table 1 shows the experimental condition.

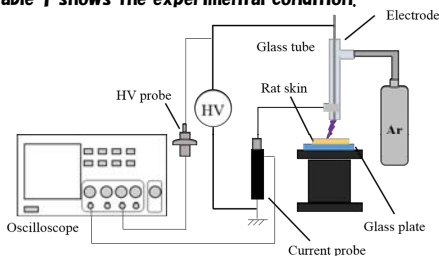


Fig. 1 An experimental setup for irradiating the plasma jet to rat skin.

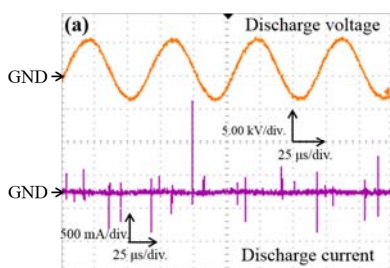


Fig. 2 Discharge voltage and current waveforms.

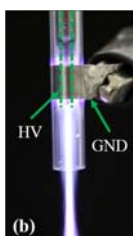


Fig. 3 Image of the atmospheric plasma discharge

Table 1 Experimental condition

| Power supply                 | AC                  |
|------------------------------|---------------------|
| Applied voltage [KV]         | 5.0 (zero- to-peak) |
| Power supply frequency [kHz] | 16.1                |
| Flow rate [L/min.]           | 5.0                 |
| Process gas                  | Argon               |
| Exposure time [min.]         | 3, 5                |

## RESULTS AND DISCUSSIONS

### (1) Observation of the rat skin surface

The rat skin surface was observed by a digital microscope after the atmospheric plasma jet irradiation. Figure 4 shows the image of the rat skin surface before irradiation. Figure 4 (a) and (b) show the image of the rat skin surface after irradiation for 3 or 5 minutes, respectively. Red circle shows the exposed area.

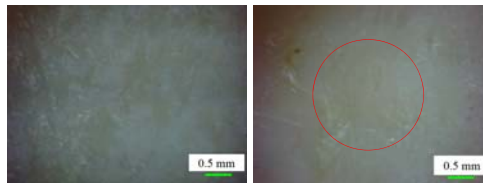


Fig. 4 Rat skin surface (a) before irradiation, (b) After irradiation for 3 minutes.



Fig. 4 (c) Rat skin surface after irradiation for 5 minutes.

Comparing the post-irradiation rat skin surface with pre-irradiation one, a slightly change in color was confirmed. Though the rat skin was exposed to the atmospheric plasma jet directly, a great change did not occur. In addition, color change after irradiation for 5 minutes was not so different from that of 3 minutes one.

The factors which contributed to these changes could be the following: an electrical damage, a thermal injury and a change of water amount on the rat skin surface. To find out the main factor of the color change, the temperature on the rat skin was observed.

### (2) Change of temperature on the rat skin surface

The temperature was observed by a thermal camera (TVS-200) when the rat skin was exposed to the atmospheric plasma jet. Measurement time of the temperature was from 30 seconds to 180 seconds. Measured temperature was maximum temperature on the rat skin surface.

Figure 5 shows the experimental apparatus and its thermal image.

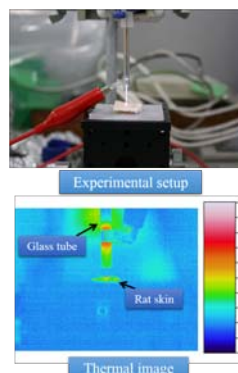


Fig. 5 An experimental apparatus and its thermal image

Figure 6 shows the change of the temperature on the rat skin.

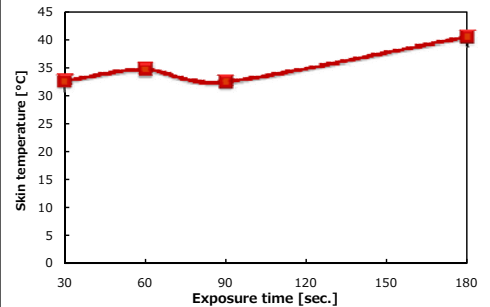


Fig. 6 Change of the maximum temperature on the rat skin surface

An increase in the temperature was observed on the rat skin surface after 180 seconds of atmospheric plasma jet irradiation. This increase of the temperature is considered by the heat which caused by the atmospheric plasma jet. A thermal injury occurred when skin was exposed to 45 °C for one hour.

The factor which changes color on the rat skin surface include the following reasons.

- A burn injury
- An electrical damage

However, the temperature achieved after 180 seconds was below 45 °C in this study. Thus it is considered that the temperature increase was not the reason for the change of color on the rat skin surface [4].

## CONCLUSIONS

Rat skin was exposed to atmospheric plasma jet to investigate the influence by atmospheric plasma jet exposure to the skin sample. The following results were obtained.

- The change of color of the rat skin surface was observed after the atmospheric plasma jet was irradiated for 3 or 5 minutes.
- Color change on the rat skin surface after irradiation for 5 minutes was not so different from that carried out for 3 minutes.
- The increase in the maximum temperature on the rat skin surface was confirmed when the atmospheric plasma jet was irradiated from 30 seconds to 180 seconds.
- The main factor of color change could be considered due to the electrical damage which appeared after 180 seconds [5].

## REFERENCE

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