04aE09P

医療用低侵襲プラズマの特性計測
Characteristic measurement of the minimally invasive plasma for the medical application

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1. Introduction

In surgical procedures, universally high-frequency electrical coagulator has been used for the hemostasis on the capillary tube. One of the plasma technologies effectively used in medical application is the argon plasma equipment for blood coagulation called as an argon plasma coagulator (APC), which performs an ablation of residual tumor and hemostasis under the endoscopic treatment [1]. However, those equipments absolutely induce burning or tissue damage caused by the heat. These injuries have possibilities to induce postoperative disorders. Therefore, to improve the invasiveness during the treatment, i.e., to reduce tissue damage, we have newly developed a medical electrical equipment utilizing low temperature plasma production technique [2]. This equipment can reduce tissue damage without impairment of the hemostatic effect [3], and the risk of postoperative disorders. Then, this medical plasma equipment is defined as “a minimally invasive plasma (MP)” for blood coagulation.

In the present study, to measure the characteristics of the MP, a near-infrared spectrometer system is prepared.

2. Experimental Setups

Specifications of the spectrometer system are as follows: focal length, f = 303 mm, a grating of 300 grooves/mm, Au coated reflection mirrors, high sensitive InGaAs photodiode array (512 pixels), low OH quartz optical fiber of 400 core diameter. In this experiment, the wavelength region from 1200 nm to 1350 nm is scanned. Wavelength resolution is 0.26 nm at 1200 nm. A cut filter of secondary light less than 700 nm is attached in front of a focusing lens of the fiber. In this study, as MP, dielectric barrier discharge based plasma equipment is adopted [2]. As a high temperature plasma, an argon plasma coagulator is introduced (ERBE Elektromedizin GmbH, Germany). Experimental arrangements are illustrated in Fig. 1.

Here, a visible emission light between nozzle exit of the equipment and copper target plate is defined as “plasma flare”.

3. Experimental Results

In the case of MP using argon gas irradiation to the copper plate, almost every detected spectral lines are corresponded to ArI emission. The emission intensity is divided by the exposure time of photodiode array.

In contrast, in the case of APC irradiation to the copper plate, dominant spectral lines are also corresponded to ArI emission. However, weak spectral line of OI (1316.4 nm) is measured. It can be considered that the energy of APC is larger than that of MP.

Furthermore, in the case of minimally invasive plasma using a helium gas, the spectral lines show specific features.

Acknowledgements

This work was supported by Grants-in-Aid for Scientific Research on Priority Area (24108006) from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

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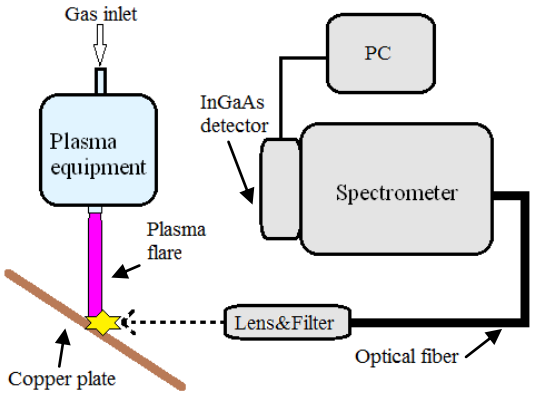

Fig. 1. Schematic drawing of a measurement system of the near-infrared emission light.