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Measurement of oxidization power of plasma produced reactive oxygen radicals with chemical probes

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1. Introduction

Recently, plasma sterilization with various plasma source has been gathering attention in medical field and food industry. Non-equilibrium atmospheric pressure plasma can generate chemically active species such as a hydroxyl radical and has been used for this purpose. The amount and kind of radical are different depending on plasma source (ie, electric power frequency and gas spices). However quantitative oxidization power measurement of reactive oxygen radical is still under development. In this work, this calibration of chemical probes is proposed with hydrogen peroxide or low energy X-ray.

2. Experiment and results

Dielectric barrier discharge plasma is produced with a low frequency power supply and the glass tube [1]. Helium or argon gas is supplied through a glass tube, electric power of about 3 kV is applied. Produced plasma jet is a few centimeters long and irradiated on water liquid media. Alcohol additional effect of argon plasma is also studied and will be presented at elsewhere [2].

Non-equilibrium atmospheric pressure plasma irradiated onto water which can generate chemically active species such as a hydroxyl radical and has been used for plasma sterilization or environmental application. Such the behavior of radicals in water can be studied with chemical probe such as Iodine Potassium(KI)-starch [3]. In order to calibrate oxidization power of reactive radicals, hydrogen peroxide was proposed as the measure of oxidization power. Figure1 shows the first result. Absorbance as the function of hydrogen peroxide concentration, is obtained with ratio beam type spectrophotometer (U-1900, HITACHI). Mixed solution of 1 % KI and 1 % starch was used as chemical probe. With this data, 3 min irradiation of our plasma jet is found to be equivalent to about 0.1 mM H_2O_2. By using this calibration curve, we can deduce how much "equivalent concentration" does plasma irradiated water has, compare the performance of different plasma source, and optimize the operating condition to achieve the most economical plasma application.

Ionization radiation such as gamma-ray has also oxidization power and its power has been studied with the similar chemical probe such as KI-polyvinyl-alcohol(PVA) [4]. KI-PVA can be prepared in gel form or normal solution form and react even with plasma irradiation. Recently, we found small vacuum discharge tube (so-called Crook's tube) has ability to emit high intensity X-ray with relatively low energy. KI-PVA response can be calibrated with this X-ray dose. Now this kind of calibration experiment is planned under radiation regulation and safety control. The first result will be presented at the conference.

References
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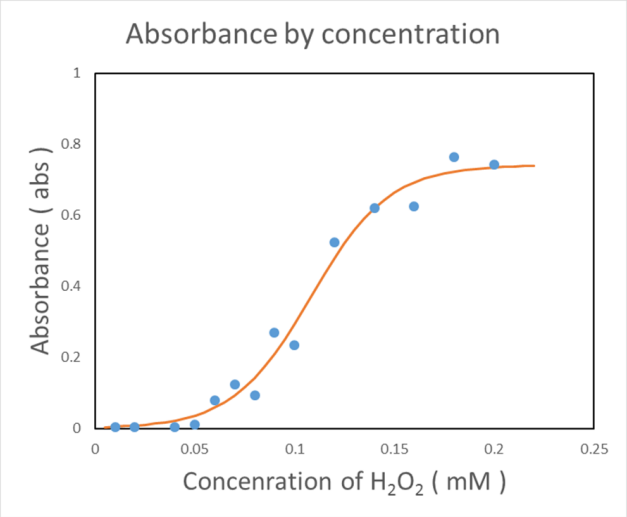

Fig 1. Calibration curve of KI-starch chemical probe. Vertical axis represents chemical probe response and horizontal axis is H_2O_2 concentration in the calibration experiment.