Comparison of ROS diagnostic methods foratmospheric-pressure plasmas at gas-liquid environment

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Reactive oxygenspecies (ROS) and reactive nitrogen species (RNS) are generated by atmosphericpressure plasmas and ROS/RNS have been widely studied for bio-medicalapplications. Especially, OHradical has a higheroxidation potential in ROS and is significant for many reactions. Up to now, various methods have been appliedfor the diagnostic on OH radicals. These methods includeoptical emission spectroscopy (OES), laser absorption spectroscopy such as cavity ring-down spectroscopy (CRDS), laser-induced fluorescence (LIF), electron spin resonance (ESR), andmass spectrometry (MS). We haveintroduced a chemical probe method (CP) for the detection of OH radicals in aqueous solution produced by plasmas process. This method is based on the trapping of OHradicals by a chemical probe and its product is mesured by fluorometricanalysis. Especially, terephthalic acid (TA) is suitable forchemical probe and its products, 2-hydroxyterephthalic acid (HTA), can bedetected by fluorescence measurement. This method iscalled as TA dosimetry.

In this study, TA dosimetry is improved to investigate not only thedetection of the OH radicals but also the estimation of absolute density. To evaluate the density, spin-trapping ESR was usedfor a cross check the density deduced by TA dosimetry. Although the same tendency for the time integrateddensity of OH radicals was confirmed, there is a diffrence for absolute densitycalculated by both methods. Consequently,the calibration between two methods was carried out to investigate thequantitative analysis.

Moreover, as HTA molecules diffuse in aqueoussolution, we could not obtain the information of OH radical distribution from the plasma source. We have developed a smarthydrogel, which consists of TA content water in agarose. We prepared a hydrogelsheet containing TA and used for the detection of OH radicals produced by several non-thermal plasmas. The detection of OHradicals in several plasmas sources such as plasma jets, dielectric barrierdischarge (DBD), and streamer coronas were perfomed experimentally. The fluorescence image appearsdue to OH radicalsaccumulated on the hydrogel sheet andits intensity increases with plasma processing time. Especially, the two dimensinal distribution of fluorescence image and itsintensity reflects on the types of plamsa sources. From these results, it is found that hydrogel sheet isuseful for the visualization of OH radical distribution inside the plasmareactors.

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