Atomic Oxygen Behavior in Sub-atmospheric Pressure Pulsed Corona Discharge

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Atmospheric pressure plasma can be applied to various fields. Plasmas in sub-atmospheric pressure, which is slightly reduced from the atmospheric pressure (namely 0.1-0.9 atm), can extend the radical lifetime with the radical production equivalent to atmospheric plasma. This leads to an increase in radical flux without compromising the diversity of the target[1]. In this study, we investigated the behavior of atomic oxygen, one of the most important oxidative radicals, in sub-atmospheric pressure pulsed discharges.

Ground state atomic oxygen O(2p^4 ^3P) in sub-atmospheric pressure pulsed O_2 discharge was measured using conventional TALIF technique. The electrodes consist of a stainless needle anode and a stainless sphere cathode covered by a glass hemisphere. Pure O_2 was flowed in the reactor at a pressure of 20–90 kPa. A 300-ns-duration pulsed high voltage was applied at 10 pulses/s to the needle. The discharge energy was adjusted to approximately 3 mJ. In the TALIF measurement, a 226-nm pulsed dye laser excites the atomic oxygen, and the 845 nm fluorescence was detected by a photomultiplier tube after passing optical filters. The observed volume was W5 × D6.25 × H0.005–0.01 mm^3, where the height was confined by the vertical height of the laser. The absolute amount of atomic oxygen was calibrated by Xe-TALIF[2].

Temporal profiles of atomic oxygen at 20–95 kPa near the cathode are represented in Fig. 1. Figure 1 exhibits the extension of the atomic-oxygen lifetime by decreasing pressure, whereas the peak O density was not proportional to the O_2 pressure. Figure 2 represents the peak O density at immediately after discharge. According to Fig. 2, there is a local maximum of peak O density near 50 kPa. The relative O yield was estimated by the time integral of O density; the estimated O yield resulted in a local maximum of O yield at 50 kPa, which was 6 times larger than that in atmospheric pressure. In the sub-atmospheric pressure range (20–70 kPa), the O density near the cathode was significantly larger than that near the anode. The experimental results suggest that the specific production of atomic oxygen near the cathode arises from low energy electrons which does not contribute to discharge emission.

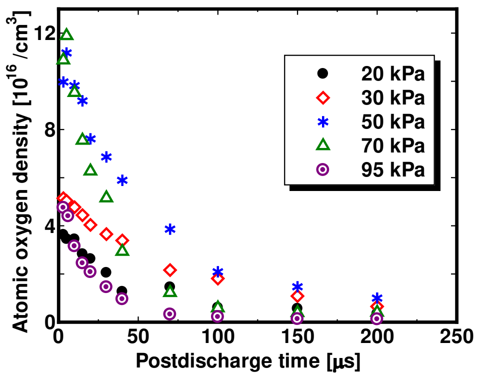

Fig. 1. Time evolution of O near the cathode.

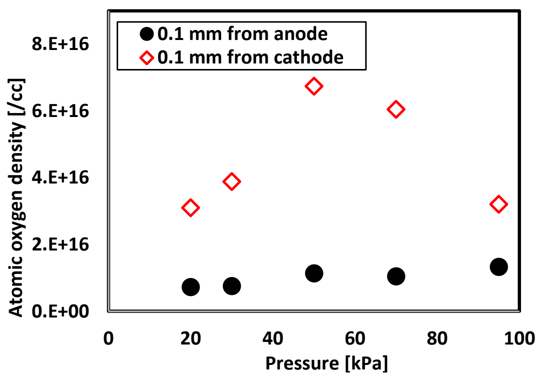

Fig. 2. Pressure effect of max O density.

[1] Y. Nakagawa *et al.*, *J. Appl. Phys.*, **131**, 113304 (2022).

[2] A. V. Klochko *et al.*, *Plasma Sources Sci. Technol.*, **14**, 375 (2005)

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