Observation of He_2 Molecular Emission at Intersection of IR Laser Beam and Plasma Plume in DBD Microplasma Jet

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Atmospheric-pressure plasma jets (APPJs) have attracted much interest of researchers in recent years, because of their potentials to be applied to material, liquid and biomedical processes. We have investigated discharge mechanisms in a widely used APPJ using a coaxial dielectric barrier discharge (DBD) configuration [1], and reported spatiotemporal behaviors of excited species in the plasma plume measured by laser spectroscopic methods [2]. In this paper, we report on the observation of enhancement of *visible red* emission at an intersection of *infrared* (IR) laser beam and plasma plume in the APPJ. This enhanced emission could be observed clearly when we used small-bore glass capillary tube (called a "microplasma jet") and relatively high-frequency applied voltage.

Figure 1(a) shows discharge emission near the capillary exit in the microplasma jet. The capillary tube had a 1.25-mm bore and a He gas flow was fed at 5 L/min into the capillary. Two nickel wires were twisted around the capillary used as electrodes, because the efficiency of excited-species generation in the plasma plume was increased as decreasing the electrode area [3]. The waveform of AC high voltage applied to the downstream wire electrode was roughly square-pulsed shape at ±2 kV and 90 kHz.

When the laser beam at 1083 nm corresponding to He 2^3S-2^3P transition energy intersected the plasma plume at 2 mm from the capillary exit, we observed a visible red emissive spot at the intersection of the laser beam and plasma plume as shown in Fig. 1(b). In addition to the digital camera observation, we measured optical emission spectra and temporal evolutions of He metastable (2^3S) atom density at the intersection. The results suggest that the red emission can be identified as He_2 $d^3\Sigma_u^+$-$b^3\Pi_g$ (0-0) band, and the formation of He_2 molecules is caused by the IR laser excitation of He atoms from 2^3S to 2^3P state. We will discuss the formation mechanisms of excited He_2 ($d^3\Sigma_u^+$) molecules from excited He (2^3P) atoms.

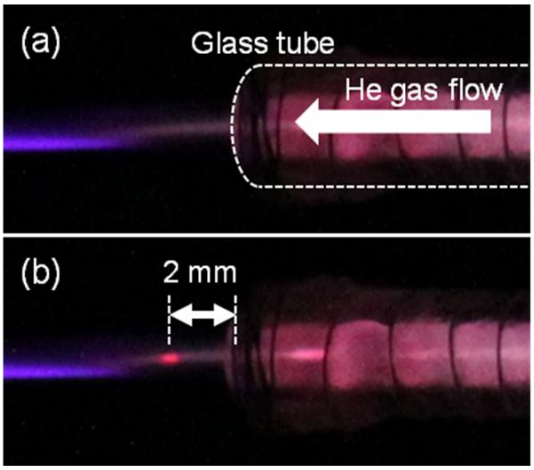

Fig. 1: Photographs of discharge emission near capillary exit in microplasma jet taken (a) without and (b) with IR laser beam at 1083 nm intersecting 2 mm from capillary exit.

References

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