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Vibration and rotation temperature distributions optimization of microwave plasma jet in atmospheric pressure

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Atmospheric pressure plasma jets are distinguished by their low processing temperature, ability to generate abundant active species, and portability. In recent years, they have found widespread application in fields such as sterilization and disinfection, food processing, biomedicine, and material modification. Typically, plasma jets can be generated using power sources including pulsed, alternating current (AC), direct current (DC), radio frequency (RF), and microwave sources. Compared with other excitation modes, microwave-driven plasma jets offer advantages such as higher electron density, a richer production of active species, lower cost, greater portability, and stronger adaptability. Discharge characteristics are the primary factor influencing the application effectiveness of microwave jets.

In this paper, the discharge characteristics and reactive species of atmospheric pressure pulse-modulated microwave plasma jets are diagnosed using emission spectrum diagnosis. According to the emission spectrum measured by the experiment, the spatial resolved rotational temperature, vibrational temperature, and electron density are calculated under different discharge parameters. The experimental results show that pulse-modulated microwave plasma jets can produce abundant active species and that the microwave power and duty cycle can effectively regulate the characteristics of microwave discharge. The vibrational temperature is the highest at the tip of the needle, while the rotational temperature is more evenly distributed in the radial direction. Under conditions of high power and a high-duty cycle, active species can be generated, and the rotational temperature can be significantly increased. In contrast, the vibrational temperature remains low at a high-duty cycle.

References

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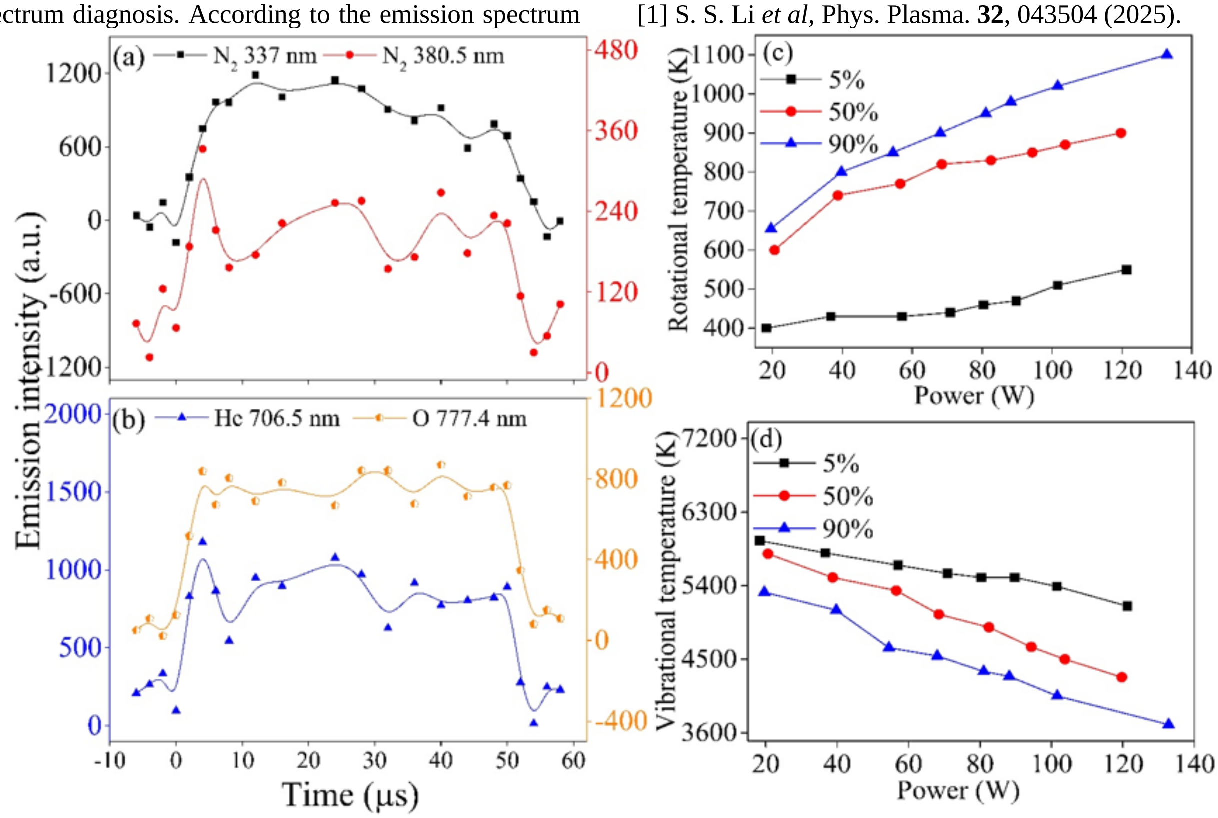

Figure 1. Time-resolved OES of (a) $N_2(C^3\Pi_u \rightarrow B^3\Pi_g,\ \Delta\upsilon = 0)$ 337 nm, $N_2(C^3\Pi_u \rightarrow B^3\Pi_g,\ \Delta\upsilon = -2)$ 380.5 nm; (b) He(3^3S-2^3P) 706.5 nm and O(3*p*-3*s*) 777.4 nm; The effects of pulse power and pulse duty ratio on (c) rotational temperature T_{rot} and (d) vibrational temperature T_{vib}.