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Application of optical wave microphone for plasma jets

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Optical wave microphone, which works based on Fraunhofer diffraction of laser beam, is unique technique to detect pressure waves and/or ionic wind emitted by atmospheric pressure plasmas such as gliding arc, dielectric barrier, corona discharges and plasma jets. Regarding plasma jets, pressure waves emitted by atmospheric helium plasma jets, which is difficult to be caught by other optical methods, were able to be detected by the optical wave microphone. For understanding the impact of pressure waves on targets, synchronized observations between pressure waves and the behavior of target (fine particles) were done using the optical wave microphone and high-speed camera. As shown in Figure 1, the optical wave microphone was set below plasma jets device and it was synchronized with the high-speed camera by an external trigger. In order to eliminate the influence of applied electric field on particles' movement, burst mode of sinusoidal pulsed applied voltage was applied. The synchronized measurement showed strong relation between pressure waves and fine particles' movement. As shown in Figure 2, plasma jet could be observed at the moment of applied voltage, however, particles showed no changes at the striking by plasma jet. On the other hand, optical wave microphone showed a signal several 10 ms after the plasma jet and synchronized high-speed camera image showed particles' movement in spite of zero electric field to the particles.

Moreover, because the sensitivity of the optical wave microphone is decided by the refractive index of helium/air mixture, ultrasonic waves were emitted from an ultrasonic oscillator during plasma jets to know helium/air mixture ratio below plasma jets experimentally and evaluate the intensity of pressure waves correctly by knowing the mixture ratio. As a result, the optical wave microphone showed potential to estimate helium/air mixture ratio below plasma jets by measuring the intensity and velocity of ultrasonic waves. Additionally, the intensities of pressure waves observed with the ultrasonic waves can be evaluated correctly in spite of different conditions of helium/air mixture. As such, in this talk, the author would like to introduce how to use the optical wave microphone to understand plasma jets and plasma-target interactions.

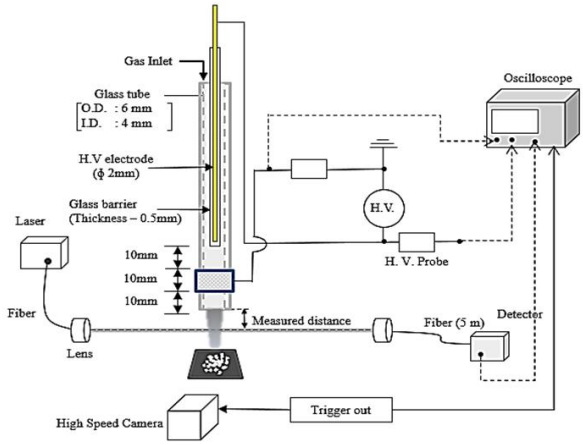

Figure 1 Experimental setup of synchronized optical wave microphone and high-speed camera observation.

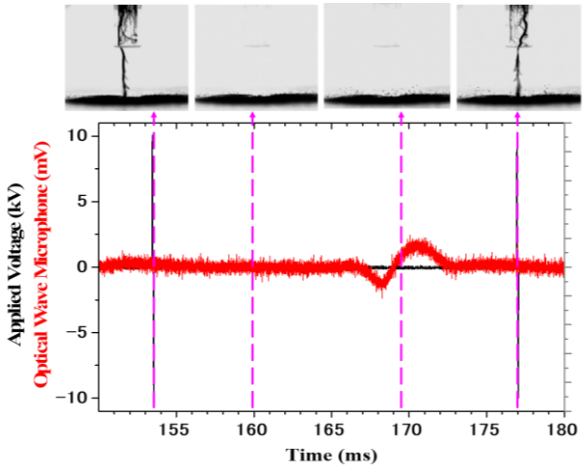

Figure 2 Synchronized observation of optical wave microphone and high-speed camera images for plasma induced particle flow.

References
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