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Studies of Pulsed Filament Discharges Using Laser Thomson Scattering Diagnostics

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Non-thermal plasmas produced at atmospheric pressure have been paid much attention for their great possibility to expand application fields of plasmas, such as plasma nano science, plasma biomedicine, and plasma chemistry. We present an experimental study in non-thermal plasmas and streamer phase at around atmospheric pressure. Generally, such plasmas occur in the form of very rapid pulse in order of nano second. So, the direct measurement of electron density and electron temperature are very difficult. In order to measure such plasmas parameters, we have been developing laser Thomson scattering (LTS) as a diagnostic system. Figure 1 shows the experimental setup of LTS system. The light source of LTS is the second harmonics Nd:YAG laser having a wavelength of 532nm, a repetition rate 10 Hz, and a pulse width of 6 ns which is injected in pulsed filament discharge. The laser is controlled using an external trigger to synchronize the laser timing with the discharge. Also a triple grating spectrometer (TGS) having high rejection rate is used to measure LTS spectra. Finally, the scattered spectrums are detected by an ICCD camera (Princeton, PI-MAX UNIGENII). In order to observe a clear spectrum, the signals are averaged over a number of 2000 shots. As a plasma source, we have selected capacity coupled discharge (CCD) and dielectric barrier discharge (DBD) separately, which are a type of the non-thermal plasma. The pulsed filamentary discharge in both plasma sources are generated in neon gas at a pressure of 400 Torr by applying the repetitive voltage pulses at a frequency of 10 Hz with a peak value of 3.0 kV. The electrode set is consisted of a needle electrode and a hemispherical electrode with a gap of 0.5 mm. Moreover, in DBD micro plasma, Teflon as a dielectric layer is coated on the hemispherical electrode. In this study, we measured temporal evolution of electron density and electron temperature as well as spatiotemporal evolution. In both plasma sources, the value of electron density remains almost constant for the first 30 ns, and then decreases monotonously. On the other hand, the electron temperature is 1.5 eV or more for the early time, then decreases rapidly down to about 0.8 eV at 50 ns by the elastic collision with the neutral particle and the ion. The error ranges for these values were estimated to be about ± 15%. Also the total electric charges that flow through the discharge channel vary from 20 nC to 800 nC by changing the capacitance in electrical circuit. We could show that the total charge variation leads to increase in electron density from 10^{22} m^{-3} to 10^{23} m^{-3}. However, the electron temperature remains almost constant at the main discharge. In order to investigate the streamer phase, we changed the gap up to 16mm. the beginning of the discharge was controlled well in time and position. Then the LTS method was performed to measure the same procedures which we had done in non-thermal discharge.

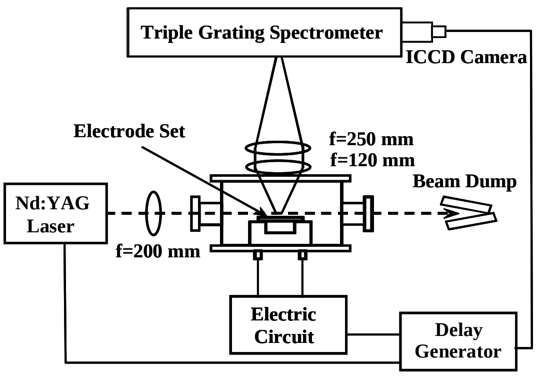

Fig. 1 Schematic illustration of laser Thomson scattering setup