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SPATIAL AND TEMPORAL PROBING OF PARTICLE DENSITY IN UV LASER GENERATED PLASMA AND HIGH PRESSURE TE DISCHARGE PLASMA

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A thesis submitted on partial fulfillment of the requirements for the degree of Master of Philosophy

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Hong Kong Baptist College

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ABSTRACT

Since the refractive index of plasma is very sensitive to the density of free electrons, a specially designed Michelson interferometer is established to probe the transient plasmas, generated by pulsed laser and by pulsed gas discharge, respectively. With a moving mirror in the interferometer and a phase comparator control system, the phase angle of the sinusoidal signal was tracked and the plasma was initiated whenever the detected phase angle matched a pre-defined value. The transient interference waveform produced as a consequence of the plasma formation was then synchronously captured. This modified set-up features minimal vibration isolation, fast response, powerful noise rejection, and a detection limit of a thousandth of a fringe shift.

Temporally and spatially resolved interference observations were performed for the LGP (laser generated plasma) from a solid sample by the ablation of a short uv laser pulse (15 ns, 308 nm) in vacuum and in gas environments. The sample materials are pure metal (copper), alloy (brass) and metallic oxide (Al_2O_3), respectively. The velocity distribution of electrons, probable expansion velocity of its stream, and threshold of electrons ejection could all be determined with these interference measurements. The characteristics of the LGP are proven to be dependent upon the sample material as well as the pressure and the compositions of the atmosphere surrounding it. The shock wave and caging effect could be determined from the variation of the interference signal waveform as well. An example is the study of the LGP in an argon atmosphere. The angular distribution of the electron density is found to be isotropic.

Interference measurements were also performed on the HPTE (high pressure, transversely excited gas discharge) plasma occurring in a nitrogen laser chamber. It was found that the laser output energy was approximately proportional to the electron density of the discharge plasma, and the laser action starts with the rise of electron density.

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