Electron Density and Temperature Measurements in Pulsed Atmospheric Pressure Air Plasmas

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In order to measure the spatially resolved electron density in high pressure glow discharges with characteristic dimensions of less than one millimeter, CO_2 laser interferometry has been used [1]. At this wavelength (10.6 μm) the index of refraction of atmospheric air plasmas with electron densities on the order of 10^{13} cm^{-3} and less is mainly determined by the neutral particles. In order to obtain information on the density of the electrons, the discharge was operated in a pulsed repetitive mode with pulse duration varying between 100 μs and 50 ms. Since the electrons have a much shorter relaxation time than the heavy particles, the fast change of the refractive index of a pulsed discharge during breakdown was considered to represent the electron part in the index of refraction, slower changes the heavy particle part. Conclusions on the dc values of the index of refraction, and consequently the dc density of electrons and neutral particles were obtained by extrapolating the results obtained with pulsed operation.

The temporal resolution of the interferometric method is on the order of microseconds [2]. In order to obtain information on electron densities (and electron temperatures) with a temporal resolution on the order of nanoseconds, as required for pulsed nonequilibrium plasmas [3], continuum radiation spectroscopy is being used [4]. Due to the low degree of ionization (approximately 10^{-6} cm^{-3}) in the high pressure glow discharges, interaction of electrons with neutrals is the dominant mechanism for bremsstrahlung radiation. The electron temperature is obtained by comparing the measured continuum spectra to computed spectra. The electron density can be obtained through absolute radiation measurement. First successful experiments with argon as working gas have been performed. Experiments with atmospheric pressure air as working gas are under preparation.

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