Electron Densities and Energies of Filamentary Atmospheric Pressure Plasmas

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Non-equilibrium atmospheric pressure plasmas offer a unique source of highly reactive chemistry at ambient temperatures. This leads to a large range of applications in medicine, material synthesis and functionalization, energy and pollution control. The room temperature chemistry in cold plasmas is driven by energetic electrons which have densities orders of magnitude smaller than the neutral densities and provide great diagnostic challenges.

In this contribution, measurement of electron densities and temperatures by Thomson scattering will be reviewed. The separation of rotational Raman scattering and Thomson scattering in Raman active gases [1] will be addressed and limitations will be discussed. Examples of electron density measurements will be shown of filamentary and diffuse discharges which are not accessible by Stark broadening measurements due to the dominant van der Waals broadening in atmospheric cold pressure plasmas [2].

Plasma filaments have the tendency to be produced randomly in space and time. It will be shown that it is possible to spatially and temporally stabilize plasma filaments in plasma jet configurations with nanosecond pulsed voltage excitation. This enables the measurement of time and spatially resolved electron density distributions in streamers in pure argon which will be discussed in detail [3].

We will highlight the importance of such measurements to unravel plasma physics and chemistry and their excellent capabilities in model validation. The limitations of Thomson Scattering will also be discussed.

References:

[1] A.F.H. van Gessel, E. Carbone, P. Bruggeman and J. van der Mullen, Laser scattering on an atmospheric pressure plasma jet: disentangling Rayleigh, Raman and Thomson scattering, *Plasma Sources Sci. Technol.* **21** (1) 015003 (2012)

[2] A.F.H. van Gessel, R. Brandenburg and P. Bruggeman, Electron properties and air mixing in radio frequency driven argon plasma jets at atmospheric pressure, *Appl. Phys. Lett.* **103** (6) 064103 (2013)

[3] S. Huebner, S. Hofmann, E. van Veldhuizen and P. Bruggeman, Electron densities and energies of a guided argon streamer in argon and air environments, *Plasma Sources Sci. Technol.* **22** (6) 065011 (2013)