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Electron Temperature Investigation in Ar/N_2 Mixture Gas in a Non-Thermal Downstream Plasma Jet Using a Plasma Propagation Speed Model

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Abstract:
A high-speed single-frame ICCD camera was employed to measure the plasma propagation velocity (u_g) for investigating electron temperatures (T_e) in a non-thermal atmospheric-pressure downstream plasma jet. Time- and space-resolved discharge images were obtained from the downstream path of an Ar/N_2 plasma jet (0–5% N_2) to determine the propagation characteristics. The propagation velocity ranged from 10^{14} to 10^{15} m/s, in agreement with ion acoustic velocities (c_s) on the order of 10^3 m/s. The plasma was generated using a 3.0 kV input discharge voltage at a driving frequency of approximately 40 kHz.
Two distinct electron energy groups were identified in the non-thermal indirect plasma jet. For slow electrons, the average electron temperature was approximately 0.33 eV for pure Ar plasma and increased to 0.42 eV for the Ar/N_2 mixture. For higher energy electrons, the average temperature was about 1.18 eV for Ar plasma and rose to 1.39 eV with N_2 admixture. These results demonstrate the influence of N_2 content on plasma dynamics and electron energy distributions, offering insight into the optimization of downstream plasma jets for various applications. Future work will further explore the impact of gas composition on plasma behavior and modeling accuracy.

Keywords : Non-thermal atmospheric-pressure plasma, downstream plasma jet, Ar/N_2 plasma, plasma propagation speed, electron temperature

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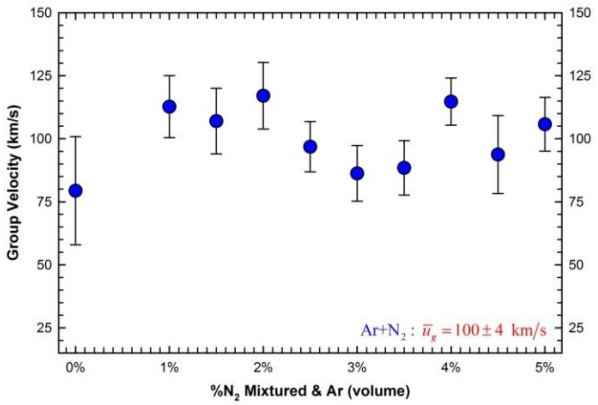

Figure 1. The plots of the group velocities versus with vary of % N_2.

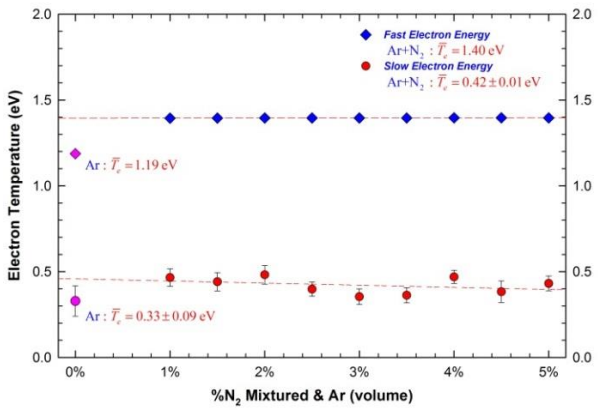

Figure 2. The plots of the electron temperature and the plasma density versus with vary of % N_2