# DIODE LASER ABSORPTION AND EMISSION SPECTROSCOPY OF A STREAMER DISCHARGE IN AN ATMOSPHERIC PRESSURE PLASMA JET

Brian L. Sands and Robert J. Leiweke
*UES, Inc. 4401 Dayton-Xenia Rd.*
*Dayton, OH 45432 USA*

Biswa N. Ganguly
*Air Force Research Laboratory, Wright Patterson Air Force Base, OH 45433*

Research into atmospheric pressure plasma jets (APPJs) that are initiated via a self-sustaining streamer discharge has recently been driven by both their potential for applications to nonthermal material processing, and fundamental questions regarding the basic discharge mechanisms that drive this remarkably stable atmospheric pressure discharge. We have characterized a streamer-initiated atmospheric pressure plasma jet in a 5% Ar / 95% He carrier gas flowing into ambient air using tunable diode laser absorption spectroscopy together with photomultiplier-coupled optical emission spectroscopy and current/voltage measurements. Improvements in the stability of this APPJ have allowed us to isolate the streamer discharge component with a higher precision than we have previously reported, as the shot-to-shot jitter is now comparable to the optical detector bandwidths. This APPJ configuration is similar to that used in previous work1, with the difference that only a single ring electrode is used here. Optical transitions from He, Ar, and various air species were used to characterize the spatiotemporal evolution of the discharge. The optical detector was aligned with the output from an 811.53 nm tunable diode laser that was used to measure the line integrated density of the Ar 1s5 metastable.

Laser absorption measurements along the capillary axis show that the streamer discharge propagating outward from the capillary begins to dominate the Ar 1s5 metastable production starting about 5 mm from the capillary tip. This rapidly propagating ionization front excited a peak measured 1s5 line density of $1 \times 10^{11}$ $cm^{-2}$ at 8 kV near the capillary tip, with a measured peak current of 1.6 mA. At 1 cm from the capillary tip, the line density was still $5 \times 10^{10}$ $cm^{-2}$, but the lifetime was significantly reduced as the effect of air entrainment increased. The increased stability also allowed us to more precisely characterize the streamer dynamics using the high electron impact excitation threshold He-triplet 33D-23P transition at 587.6 nm. The steady-state propagation speeds ranged from $1.1 \times 10^7$ cm/s at 8 kV to $3.9 \times 10^7$ cm/s at 13 kV.

1. B. L. Sands, B. N. Ganguly, and K. Tachibana, "A streamer-like atmospheric pressure plasma jet", Applied Physics Letters **92** 151503 (2008).

* Work supported by AFOSR under contract No. FA8650-04-D-2404.