MEASUREMENTS OF $N_2(A^3\Sigma_u{}^+,v)$ POPULATIONS IN A NANOSECOND PULSE DISCHARGE BY CAVITY RINGDOWN SPECTROSCOPY

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Time-resolved number densities of excited electronic state of nitrogen, $N_2(A^3\Sigma_u{}^+,v=0,1,2)$, have been measured in a nanosecond pulse discharge using Cavity Ring-Down Spectroscopy (CRDS). The CRDS spectrometer is operated using a 10 Hz Nd:YAG laser which pumps a narrowband tunable dye laser using a LDS765 dye, to produce output between 745 to 770 nm with a linewidth of 0.12 cm^{-1}. The ring-down cavity is a 10 mm x 22 mm rectangular cross section quartz channel 55 cm long, fused to two 1.5 inch diameter quartz tubes at both ends, with the total cavity length of 90 cm. The mirrors (reflectivity of 0.99995) are attached to the ends of the ring-down cavity using stainless steel adjustable mounts, for precision alignment. Two rectangular plate copper electrodes, 12 mm x 60 mm, are attached to the top and bottom walls of the quartz channel in the middle of the cavity, using silicone rubber adhesive. The electrodes are powered by a custom-built high-voltage pulse generator producing alternating polarity pulses with peak voltage up to 15 kV and pulse duration of approximately 100 ns FWHM. The pulser is operated in burst mode, with burst repetition rate of 10 Hz, pulse repetition rate of 10 kHz, and 10 pulses per burst, with coupled discharge energy of approximately 0.3 mJ/pulse. Spectra of $N_2(B^3\Pi_g \leftarrow A^3\Sigma_u{}^+,v)$ absorption bands are taken 25 μs after the last discharge pulse in the burst, with all absorption transitions identified. Time resolved CRDS data are taken from isolated rotational lines for each vibrational state to infer temporal evolution of absolute populations of vibrational levels of $N_2(A^3\Sigma_u{}^+)$ at t=25-1500 μs after the last discharge pulse. This diagnostics is being developed for measurements of excited metastable state populations of N_2 and O_2 in nonequilibrium plasmas and nonequilibrium high-speed flows.