ABSTRACT

Spectroscopic Investigation of a Repetitively-Pulsed Nanosecond Discharge

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This work reports on an investigation of a repetitively-pulsed nanosecond discharge (RPND) in helium over a range of 0.3-16.0 Torr. The discharge was studied experimentally via laser-absorption spectroscopy and optical emission spectroscopy measurements. In concert with the experimental campaign, a global model of a helium plasma was used to predict the population kinetics and a particle-in-cell code was used to analyze the EEDF evolution. Synthesis of the results provided new data and insights on the development of the RPND.

Among the results were direct measurements of the triplet metastable states during the excitation period. This period was found to be unexpectedly long at low pressures (less than 1.0 Torr), suggesting an excess in high-energy electrons as compared to an equilibrium distribution. Other phenomena such as a prominent return stroke and a additional energy deposition by reflections in the transmission line were also identified. Estimates of the electric field and electron temperatures were obtained for several conditions. Furthermore, several optical methods for electron temperature measurement were evaluated for application to the discharge. Based on the global model simulations, the coronal model was found to apply in the line ratio of the 3^3S-2^3P^o and 3^1S-2^1P^o transitions, however further work is needed to ascertain its applicability to experimental discharges.

These results provide new insight on the development of the repetitively-pulsed nanosecond discharge. Specifically, they reveal new information about the excited state dynamics within the discharge, the non-equilibrium nature of its electrons, and several new approaches for future studies. This study extends the present understanding of repetitively-pulsed discharges, and advances the knowledge of energy coupling between electric fields and plasmas.