Generation of vibrationally excitednitrogen in a DC discharge sustained by repetitive nanosecond pulses

Keisuke Takashima [1], Yuki Kunishima [1], and Toshiro Kaneko [1]

[1]Department of Electronic Engineering, Tohoku University, Japan

A development of non-thermal plasma source operatedunder atmospheric pressure nitrogen is a key for the plasma nitrogen fixation. In this study, a DC discharge, sustained by repetitive nanosecond pulses (NS), is experimentally studied in nitrogen with a single pair of exposed electrodes.The repetitive nanosecond pulse discharge generates ionization waves in nitrogen propagating along the discharge tube. A DC current to the ionized channel generated by the repetitive NS discharge can be supplied by superimposed DC voltage on the NS pulses, thus non-self-sustained DC discharge, allowing DC voltage control in a given geometry, can be achieved by combining the DC and NSvoltages. Under high pulse repetition rate ~ 20 kHz, the ionized channel across 4cm gap is developed with approximately -17 kV peak voltage. The non-self-sustained DC current almost linearly increases with the applied voltage for V_{DC} > 300 V, and the time-averaged DC current is nearly proportional to the pulse repetition rate. Therefore, the DC voltage can be controlled separately from and the discharge coupling power with the external parameters, expecting reduced electric field (E/N) control and nitrogen vibrational temperature control. A drastic jump in the non-self-sustained DC discharge coupling power is observed and increased to nearly 1kW coupled to nitrogen flow at around 200 torr with apparent reduced DC electric field ~ 1 Td. Further discharge characterization on the repetitive NS discharge and the non-self-sustained DC discharge will be presented.

This work is supported by JSPS KAKENHI Grant-in-Aid for Young Scientists (A) Grant Number 17H04817.