INFLUENCES OF GAS FLOW ON GAS TEMPERATURE AND DISCHARGE MODE IN DIELECTRIC BARRIER DISCHARGE OF NITROGEN AT ATMOSPHERIC PRESSURE*

Zhuo Liang, Hai-Yun Luo, Xin-Xin Wang, Zhi-Cheng Guan and Li-Ming Wang
Department of Electrical Engineering, Tsinghua University Beijing 100084 P.R.China

Dielectric barrier discharge in nitrogen at atmospheric pressure was studied with the spectroscopy and fast photography of the discharge. By the introduction of a nitrogen flow into the discharge gap, the homogeneous discharge in a 2mm gap could be maintained. Based on the waveform of the discharge current characterized by a current pulse per half cycle of the applied voltage and the 1μs exposure discharge photograph showing a luminous layer covering the entire surface of the anode, the homogeneous discharge was identified with a Townsend discharge. The instrumental broadening of the spectrometer used in the experiment was calibrated with a helium-neon laser. The related data to the instrumental broadening was input to a program called Specair for calculating the spectrum profiles of 0-2 band in the second positive system of nitrogen molecules at different gas temperatures. By fitting the calculated spectrum profiles to the experimental one, the rotational temperature of the nitrogen molecules was determined. The results show that the dielectric barrier Townsend discharge in nitrogen at atmospheric pressure could not heat the nitrogen to a high temperature (□Tg≤50K) and the small rising in temperature does not cause the thermal instability to develop, leading to the transition of the Townsend discharge to a filamentary discharge. By addition of a gas flow into the discharge gap, the nitrogen was really cooled down to a lower temperature. However, it is not the reason for the Townsend discharge to be maintained. By comparing the discharge spectra with and without the gas flow, it could be concluded that the gas flow much reduces the density of the impurity oxygen etched from the dielectric by the discharge and makes it possible for more nitrogen metastables to survive to the beginning time of the next discharge and to provide sufficient seed electrons which are necessary for Townsend discharge.

* Work supported by the State Key Program of National Natural Science Foundation of China （ Grant No. 50537020）