Topic number

Energy dependence of intensity ratio between nitrogen spectral lines of N II and N I from electrostatic discharge in air

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For development of practical method to estimate energy of spark discharge in air without electrical measurements, dependence of spectral characteristics of light emission from the discharge on electrostatic energy was investigated. It was found that the relative light intensity of N II to N I increased with electrostatic energy in the region from 0.1 mJ to 10 mJ.

1. Introduction

For risk assessment of fires caused by spark, minimum ignition energy of the combustibles has been well evaluated using explosion apparatus, including a spark generator and a basic electric circuit with a capacitor, resistor, induction coil, and high-voltage supply. However, estimating the energy of an actual spark—such as a spark between an electrified human body and an ungrounded conductor—from the condition of an equivalent electric circuit is impossible in practice, even if the surface potential of the human body can be measured.

We has studied spectral characteristics of spark discharge in air. It was found that the relative intensity of the emission line from N II to that from N I increased with the initial electrostatic energy of the charged capacitor. In this study, dependence of their intensity ratio on electrostatic energy was measured in detail.

2. Experiment

A spark was generated in a gap between two spherical electrodes during the process of their approaching each other; one was grounded and the other was connected to a high-voltage charged capacitor. The electrodes were made of stainless steel, and their radius of curvature was 7 mm. The speed of approach was in the region between 0.5 and 5 mm/s. The room temperature was 24-27ºC, and the relative humidity was 30-60%. The maximum voltage was 6 kV. Capacities were varied from 47 to 1000 pF. Simultaneously discharge current was measured by means of current probe with digital oscilloscope and recoded.

3. Results and discussions

Figure 1 shows the typical spectrum of a spark due to a capacitor discharge in air. The spectrum shows emission lines from electronic excited nitrogen atoms (N I), monovalent positive ions (N II), and so on.

The intensity ratio of N II to N I was measured as a function of the electrostatic energy accumulated to the capacitor before discharge, as shown in Figure 2. The electrostatic energy was varied by changing the voltage of the capacitor. The intensities were obtained by integrating the spectrum's peak without any background.

As shown in Figure 2, the relative intensity of N II increased with the electrostatic energy of the capacitor. The current measurement implied that accumulated charge was almost discharged. A function between the ratio and the energy was found, although each voltage group has individual line.

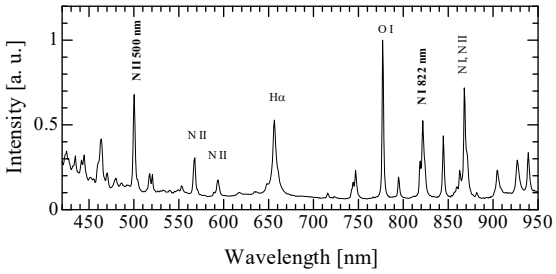

Fig.1. Emission spectrum of spark discharge (470 pF, 3.0 kV)

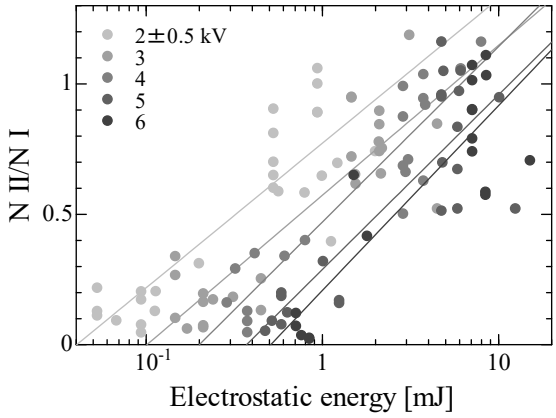

Fig.2. Relation between the relative intensity of the N II emission to the N I and the initial electrostatic energy of the capacitor, categorised by the applied voltages.