FINITE ELEMENT ANALYSIS OF RING-SHAPED EMISSION PROFILE IN PLASMA BULLET*

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In this study, we focus on the mechanisms of ring-shaped emission patterns observed in a plasma bullet. [1] Our model is based on a fluid model with the local field approximation in 1D cylindrical coordinates, corresponding to a cross-section of a plasma bullet. An expected concentration gradient of humid air is assumed to be present due to diffusion of air into helium gas flow. The current model is almost identical to our previous report [2]. The major difference is that uniform pulse-like electric field is given perpendicular to the simulation domain. The pulse width and repetition rate are determined based on experimental conditions. The magnitude of the electric field was chosen so that a periodic steady state solution can be obtained. We also performed spectroscopic measurements to investigate the structure of the plasma bullets and to compare with the simulation results.

Figure 1 shows comparison of spatially-resolved emission profiles from nitrogen second positive systems between experiment and simulation. Light emission from nitrogen clearly shows an off-centered peak (ring-shaped profile) in both experiment and simulation. Our simulation results indicate that diffusion of air (nitrogen) into the helium flow plays a key role. Penning ionization between helium metastables and nitrogen generate the ring-shaped emission profile.

1 Y. Sakiyama, D. B. Graves, Julien Jarrige, and Mounir Laroussi, Appl. Phys. Lett. (in print).
2 Y. Sakiyama and D. B. Graves, J. Phys. D 39 (2006) 3644.

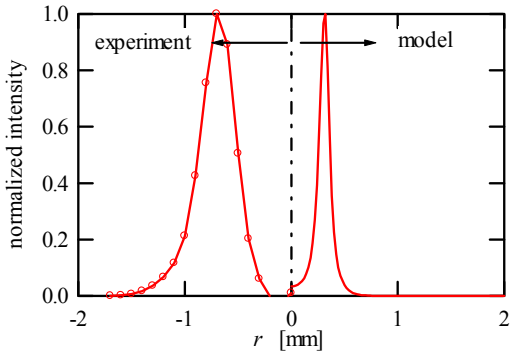

Fig. 1 Time-averaged relative emission profiles from nitrogen second positive systems.

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