Role of spectral region of discharge emission on initial electron generation for inducing surface discharge in air

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The present study clarifies the spectral region of discharge emission that is effective for triggering surface discharge in air. Light emitted from a bulk discharge generated between two needle electrodes irradiates a dielectric plate between two additional electrodes, inducing surface discharge. By changing the cut-on wavelength of an optical filter placed between the needle electrodes and the dielectric plate, the range of wavelengths that effectively generates the initial electrons that trigger the surface discharge is measured. The triggering probabilities change abruptly between 112 nm and 125 nm (9.9 - 11 eV), where oxygen and nitrogen emission lines are located. Thus, these lines play an important role in triggering surface discharge under the conditions used.

1. Introduction

Understanding the supply mechanisms of initial electrons is valuable knowledge because it is useful for both practical application and inhibition of discharge. This report investigates which discharge emission wavelengths are effective for generating the initial electrons that induce surface discharge.

2. Experimental setup and procedure

Figure 1 shows the experimental setup. Light emitted from a bulk discharge generated by needle electrode system Eb passes through an optical filter and irradiates the vicinity of an electrode Es, inducing surface discharge. The probabilities that the light emitted from the bulk discharge triggers surface discharge are measured for different filter cut-on wavelengths. The number of trials is 100 for each filter and the impulse voltage applied to Es is +30 kV, 0.7/80 μs.

3. Result and discussion

The results are shown in Figure 2. In the cases of no filter (w/o) and a 112-nm filter (MgF_2), the discharge probability is high. The probability rapidly decreases from 112 nm to 125 nm (CaF_2). Thus, the emission wavelengths of 112nm - 125 nm play an important role in triggering the surface discharge under the conditions used.

4. Conclusion

Several oxygen and nitrogen emission lines are located in this region [1]. Furthermore, the photoabsorption coefficient for O_2 in this range is relatively small only in several narrow regions [2]. Therefore, it is considered that the emission spectral lines between 112 nm and 125 nm (9.9 - 11 eV) play an important role in generating the initial electrons that lead to surface discharge in air.

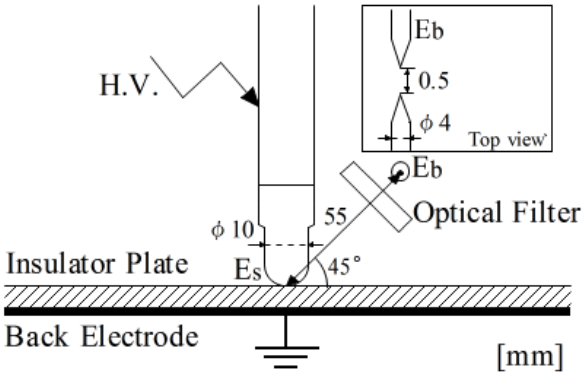

Fig. 1. Schematic diagram of the experimental setup. Surface discharge around Es is triggered by bulk discharge generated around Eb (perpendicular to the paper).

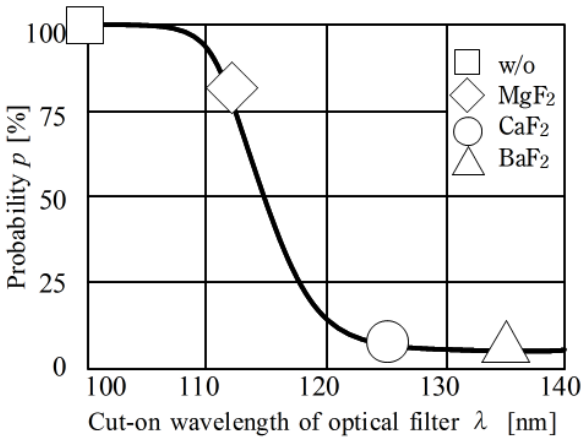

Fig. 2. Measured probability of triggering discharge on insulator plate by bulk discharge.

5. References

[1] T. G. Rogers, et al., IEEE Trans. on Plasma Science, 38, 10 (2010) 2764-2770

[2] K. Watanabe, et al., J. Chem. Phys. 21 (1953) 1026-1030