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双方向トリガーダイオードを用いた誘電体バリア放電特性の改善

Improvement of Dielectric Barrier Discharges using Silicon Diode for Alternating Current

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1. Introduction

In order to obtain stable and efficient DBD plasmas it is usually required to use high voltage and high frequency power sources and/or high voltage pulse sources with high repetition rate. When large volume DBD plasmas are necessary for environmental and engineering applications, generation of such plasmas also requires expensive and complicated power sources. In this paper, we have been studied the enhancement effects of atmospheric He DBD plasmas by using a Silicon Diode for Alternating Current(SIDAC) as a simple high voltage power source with rapid voltage change.

2. What is SIDAC?

The SIDAC is designed for direct interface with the ac power line. The operation of the SIDAC is functionally similar to that of a spark gap. Figure 1 shows an example of *I-V* characteristic of 10 SIDACs connected in series. The SIDAC remains non-conducting until the applied voltage meets or exceeds its rated breakover voltage (V_{BO}). Once entering this conductive state going through the negative dynamic resistance region, where conduction current is larger than the breakover current (I_{BO}), the SIDAC continues to conduct, regardless of voltage, until the conduction current falls below its rated holding current(I_H). At this point, the SIDACs return to its initial nonconductive state to begin the cycle once again. In general, the SIDACs is inexpensive and easy to use. In the present experiments, we used the SIDAC (Model No. K1V38(W)) made in Shindengen industry, which has the highest V_{BO} of 360~400 V. Although the VBO of the present SIDAC is not enough high for DBD plasmas, series connection of N SIDACs allows us to have much higher operation voltage given by $V=N\times V_{BO}$. For example, the switching voltage (effective breakover voltage) is increased to be 3,600 ~ 4,000 V with 10 series SIDACs.

3. Typical DBD waveform using SIDACs

Figures 2 shows typical waveforms of transform secondary voltege(Vo), SIDAC applied voltage(V_{SIDAC}) and DBD applied voltage(V_{DBD}), DBD discharge current including the charging of DBD(I_{DBD}) and emission intensity from DBD plasmas when 15 SIDACs were used. When Vo meets or exceeds V_{BO}, SIDAC turns into the conductive ON state from OFF state quickly and a high voltage pulse is applied to the DBD plasma reactor simultaneously. Typical switching time of series SIDACs observed in the experiment is about 200 ns. The voltage rise rate of dV_{DBD}/dt ~20 kV/µsec is obtained when 15 SIDACs are used. At the same time, small I_{DBD} of ~40 mA can be seen firstly. After this small DBD event second large DBD pulse current of 0.5~1 A and ~200 ns width flows with a random delay time from the first DBD pulse. Corresponding to two DBD pulses visible light emission can be seen after ~20 µsec delay. DBD characteristics in positive and negative polarities are neary same in the present configuration as shown in Fig. 2. More than 10 times enhancement of DBD current and emission intensity is obtained by using 15 SIDACs from those without SIDACs.

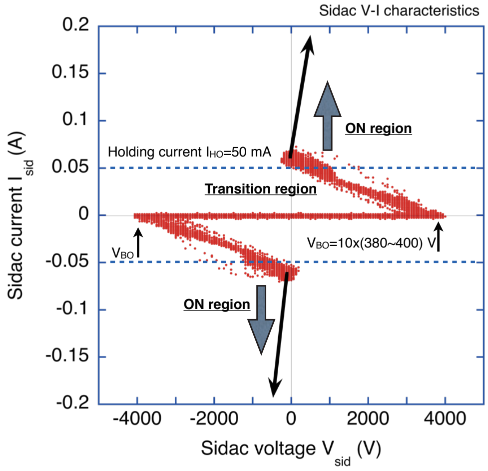

Fig. 1 *I-V* characteristic of 10 SIDACs connected in series.

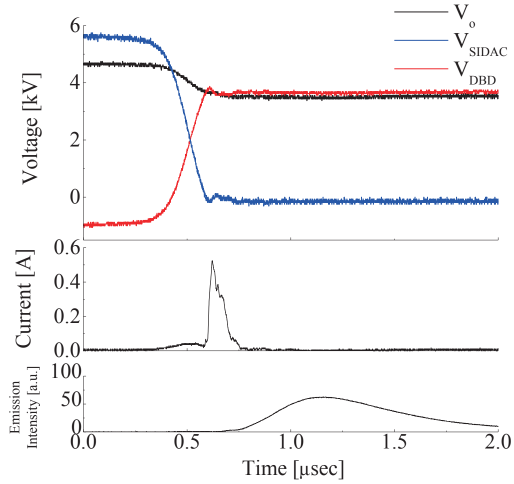

Fig. 2 Typical waveform of the DBD circuit with 15 SIDACs.