Characteristics of Sustain Discharges in AC PDP with various Coplanar-Gaps and Auxiliary Electrode

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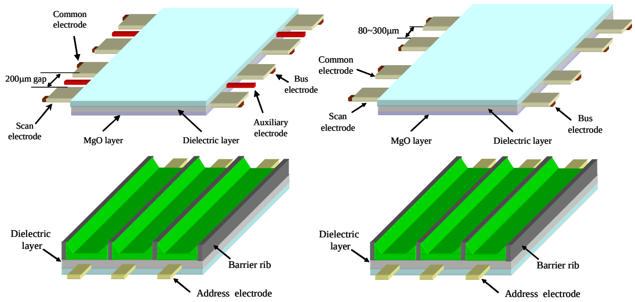
Abstract

The spatio-temporal behaviors of Infra Red(IR) emission images of the sustain discharges were observed in AC PDP with various coplanar-gaps and auxiliary electrode. When the height of barrier rib was fixed, IR intensity of the sustain discharges in AC PDP did not increase with increase of coplanar-gap. The IR efficiency of sustain discharges showed the similar behavior with the IR intensity. The IR intensity had its maixmum value when the coplanar-gap was 200 μm and the height of barrier rib was 150 μm. It was also found that the auxiliary electrode in the front plate enhanced IR emission during sustain discharge when the pulse was applied to the auxiliary electrode.

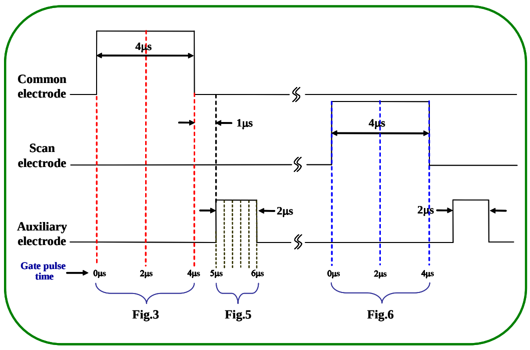
1. Introduction

It is well known that the discharges in an AC PDP with Ne+Xe gas-mixtures are very inefficient from the point of view of energy flow. The improvement of the luminous efficacy in an AC PDP is very important to save power consumption. The improvement of luminous efficacy is related to how to make more excitation particles. For improving electron excitation rate, there are some promising approaches such as high Xe content and long-gap discharge mode [1, 2]. In our previous works, the AC PDP with 200㎛ sustain-gap and the auxiliary electrode was proposed and its discharge characteristics was investigated [3, 4]. However, the detail mechanism of the improvement in luminous efficacy and operation voltage was not known. In this work, the spatio - temporal behaviors of the discharges in AC PDP with various sustain - gaps and auxiliary electrode were observed using ICCD(Intensified Charge Coupled Device) camera. We also tried to find out the role of the auxiliary electrode during sustain discharges.

2. Experiment



(a) (b)



(c)

Fig.1 (a) Schematic diagram of the AC PDP with 200μm and auxiliary electrode (b) Schematic diagram of the AC PDP with various coplanar-gaps (c)Pulse waveforms applied to common, scan, and auxiliary electrode

Fig.1(a) shows the schematic diagram of the AC PDP with 200㎛ coplanar-gap and auxiliary electrode. The sustain electrodes(common and scan) were formed with the gap of 200㎛ and the auxiliary electrode located at the center of them. Fig.1(b) shows the schematic diagram of the AC PDP with various coplanar-gaps. The common and the scan electrodes were formed with various coplanar-gaps from 80 to 300μm. The coplanar-gaps between common and scan electrode were 80, 150, 200, and 300μm. The Ne + 4%Xe gas-mixtures were used as discharge gases. The total gas pressure was 450Torr. The height of the barrier rib was fixed as 150μm. Fig.1 (c) shows the pulse waveforms applied to the sustain electrodes and the auxiliary electrode during sustain period. The frequency of sustain pulse is 50 kHz, and duty factor is 20%. When the common electrode was an anode during sustain discharges from 0 to 4 μsec, the IR emission was observed as shown in Fig.3 without the auxiliary electrode. When the common and the scan electrode were grounded during afterglow from 4 to 6 μsec, the IR emission was observed with applying to the pulse to the auxiliary electrode as shown in Fig.5. When the scan electrode was an anode right after the pulse was applied to the auxiliary electrode, the IR emission was observed as shown in Fig.6.

Fig.2 shows schematic diagram of the observation system using ICCD camera. We observed the 823 and 828nm photons emitted from sustain discharges using IR filter. The driving pulse and the gate pulse of ICCD camera was synchronized with the driving circuit.

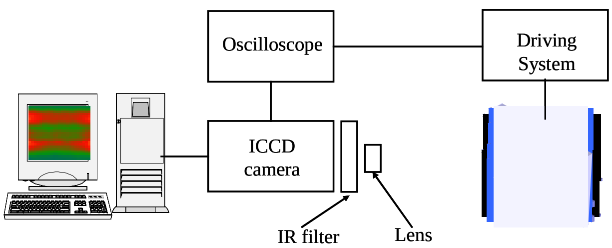


Fig.2 Schematic diagram of the observation system using ICCD camera

3. Results and discussion

Fig.3 shows the temporal behaviors of the IR emission from various sustain-gaps discharge. They were measured under same frequency, duty, and ICCD's gain value using the gate mode(exposure time : 20ns) of the ICCD camera. From the results, IR emission become stronger and faster as the coplanar-gap increased until 200μm. When the coplanar-gap was 300μm, IR intensity was weaker than that of 200μm sustain-gap discharge. The width of IR emission shape got narrowed at the center of sustain discharge.

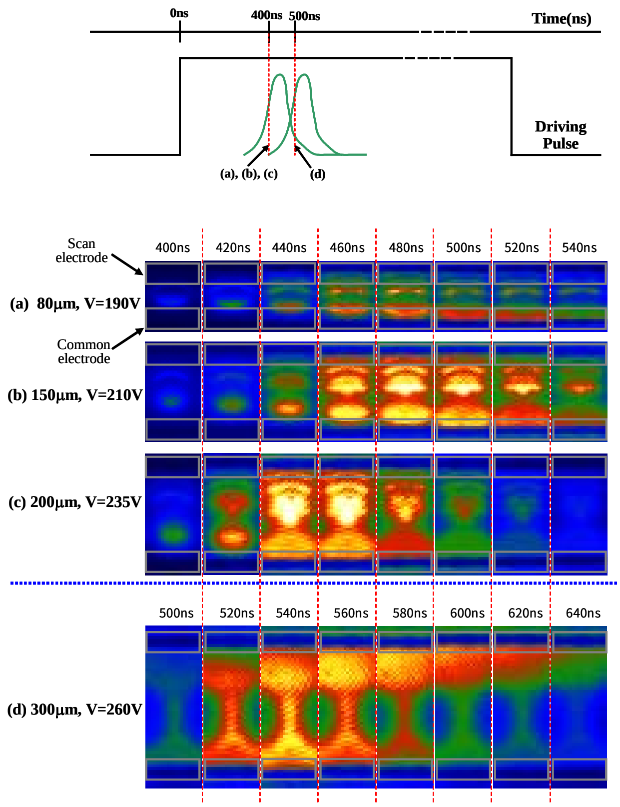
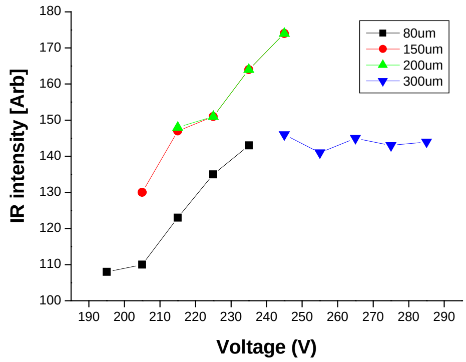
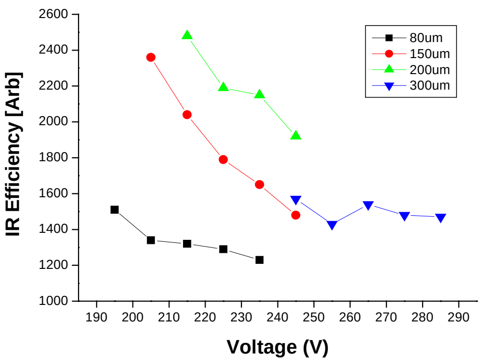


Fig.3 IR emission images of sustain discharges in accordance with coplanar-gaps (a) 80μm (b) 150 μm (c) 200 μm (d) 300 μm

Fig.4 shows the IR intensity and efficiency of Ne + 4%Xe gas-mixture discharge as a function of sustain voltage in accordance with coplanar-gaps. The relative IR efficiency was obtained by the IR intensity divided by discharge power. Within 200μm sustain gap, the IR intensity of Ne + 4%Xe gas-mixture discharge increased with increasing of coplanar-gaps as shown in Fig.4(a). Also, the value of IR intensity of 200μm sustain-gap discharge is the greatest than any other gap discharges. The value of IR intensity of 300μm sustain-gap discharge was lower compared to those of 80~200µm sustain-gap discharges. Fig.4(b) shows the IR efficiency of various sustain-gap discharges. Within 200µm sustain gap, the IR efficiency increased with increasing of sustain gap and decreased with increasing of sustain voltage. In the case of 300µm sustain-gap discharge, the IR efficiency seemed to be decreased. Finally, the IR efficiency of 300µm sustain-gap discharge was lower than that of 200µm sustain-gap discharge.



(a)



(b)

Fig.4 IR intensity and efficiency of Ne + 4%Xe gas-mixture discharge as a function of sustain voltage in accordance with coplanar-gaps (a) IR intensity (b) IR efficiency

Fig.5 shows IR emission image of the sustain discharges in the AC PDP with 200µm coplanar-gap and auxiliary electrode. Fig.5(a) shows IR emission image of the Ne+4%Xe gas-mixture discharge in 200µm sustain-gap when the auxiliary electrode is ground. During afterglow from 4µsec to 6µsec, there was nothing happened on the auxiliary, the scan, and the common electrode. When the pulse with 50V were applied to the auxiliary electrode during afterglow, IR emission image was observed as shown in Fig.5(b). It was found that there was the excitation reaction between the common and the auxiliary electrode during afterglow from 5.4µsec to 6.0µsec. The excitation reaction did not happen right after the pulse was applied to the auxiliary electrode. The delayed excitation reaction between the common and the auxiliary electrode was observed.

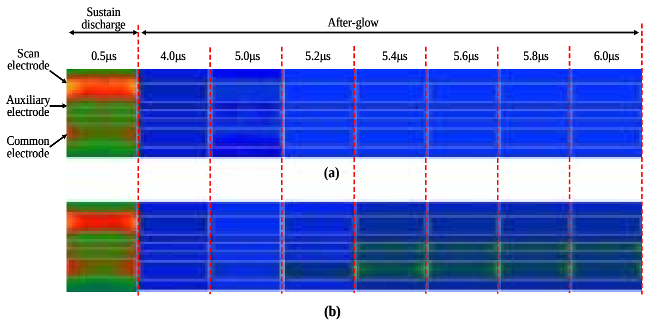


Fig.5 IR emission image of the sustain discharges in AC PDP with 200µm coplanar-gap and auxiliary electrode (a) Auxiliary electrode was grounded (b) the pulse with 50V was applied to the auxiliary electrode

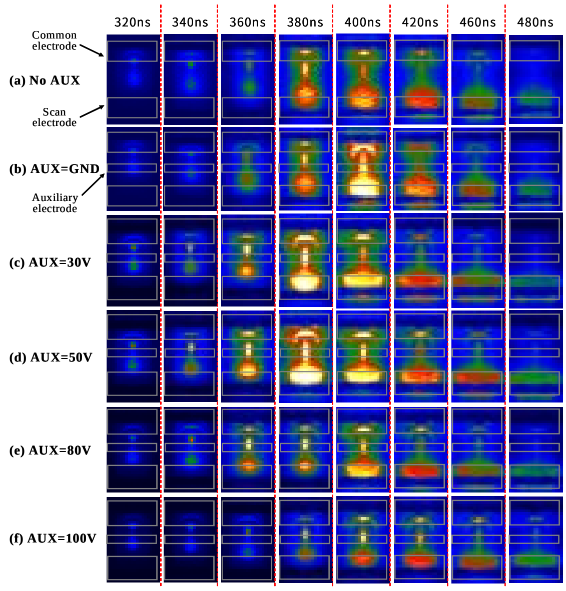


Fig.6 Temporal behavior of the IR emission image of the sustain discharges in the AC PDP with 200µm coplanar-gap and auxiliary electrode.
(a) No auxiliary electrode in 200um sustain-gap
(b) V_{aux} = GND (c) 30V (d) 50V (e) 80V (f) 100V

Fig.6 shows the temporal behavior of the IR emission image of the sustain discharges in the AC PDP with 200µm coplanar-gap and auxiliary electrode. The driving sustain voltage was 240V in this observation. Fig.6(a) shows the IR image of the sustain discharge when there is no auxiliary electrode between the scan and the common electrode. The discharge started from the common electrode(cathode) and spread to the scan electrode(anode). The maximum IR emission was observed at 400 nsec. When the auxiliary electrode was grounded as shown in Fig.6(b), the maximum intensity of IR emission was grater than that of the case of Fig.6(a). The maximum intensity of IR emission increased when the voltage of the pulse applied to the auxiliary electrode increased until 50 V. It was also found that the peak time of IR emission of Fig.6(c) and (d) was faster than any other case in Fig.6. When the voltage of pulse applied to the auxiliary electrode was 80 and 100 V, the intensity of IR emission of sustain discharge was weakened.

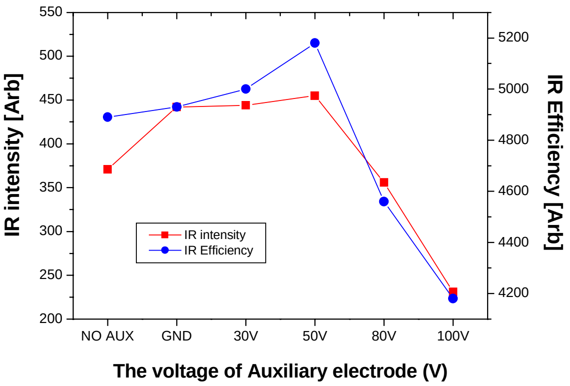


Fig.7 Variation of IR intensity and efficiency as a function of the voltage of the pulse applied to the auxiliary electrode

Fig.7 shows the variation of IR intensity and efficiency as a function of the voltage of the pulse applied to the auxiliary electrode. As mentioned at the result of Fig.6, the IR intensity and efficiency increased when the voltage of the pulse applied to the auxiliary electrode increased until 50 V. Thereafter, the IR intensity and efficiency decreased.

4. Conclusion

The IR emission characteristics of the sustain discharge in the AC PDP with various sustain-gaps and auxiliary electrode were investigated using ICCD camera. It was found that the IR emission intensity of 200µm sustain-gap discharge was the strongest among 80, 150, 200, and 300 um coplanar-gaps when the height of barrier rib was fixed as 150 um. We also observed the IR emission from 200 um sustain-gap during afterglow when the pulse was applied to the auxiliary electrode. During afterglow of sustain period, the pulse applied to the auxiliary electrode made more excitation reactions between the auxiliary and the common electrode and the auxiliary electrode. When the voltage of the pulse applied to the auxiliary electrode was 50 V, the intensity and efficiency of IR emission had their maximum value.

5. References

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