Electron Temperature, Plasma Density and Luminous Efficiency in accordance with Discharge Time in coplanar AC PDPs

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Abstract

Electron temperature and plasma density in coplanar alternating-current plasma display panels (AC-PDP's) have been experimentally investigated in accordance with discharge time by a micro-probe in this experiment. The resolution of a step mortor to move in micro-Langmuir probe is 10um.[1-3] The used gas in this experiment is He-Ne-Xe (4%) mixure gas. And sustain voltage is 320V which is above of firing voltage for degradation.

The electron temperature and plasma density can be obtained from current-voltage (I-V) characteristics of micro Langmuir probe, in which negative to positive bias voltage was applied to the probe. And Efficiency is calculated by formula related discharge power and light emission. Those experiments operated as various discharge time (0~72 Hours).

As a result of this experiment, Electron Temperature was increased from 2eV to 5eV after discharge running time of 20 hours and saturates beyond 20 hours. The plasma density is inversely proportional to the square root of electron temperature. So the plasma density was decreased from $1.8 \times 10^{12} cm^{-3}$ to $8 \times 10^{11} cm^{-3}$ at above discharge running time. And the Efficiency was reduced to 70% at 60hours of discharge running time.

1. Introduction

Degradation makes many influence at the length of life in AC-PDP. And it cause variation of panel's electro-optical characteristic, image sticking, reduction of lifetime, low brightness and so on.

Consequently, it is important to compare the properties of plasmas and efficiency. In this experiment we used Micro Langmuir Probe and measure electron temperature and plasma density. With this measurement we observed electro-optical characteristics and efficiency. The electron temperature and plasma density can be obtained from current-voltage (I-V) characteristics curve of micro Langmuir probe, in which negative to positive bias voltage was applied to the probe.[8,9]

2. Experimental Configurations

Figure 1 shows the micro Langmuir probe tip whose diameter is 20um, has been manufactured by the electro-chemical etching method.

Figure 1. Micro Langmuir probe

And used 4 inch test panel has a sustaining electrode width of 300um and gap of 90um.

Figure 2. 4 inch Test Panel

The electron temperature and plasma density can be measured by[5,6]

$$\frac{d\ln|I|}{dV} = \frac{e}{KT_e}$$

$$I_{is} = n_i eA\sqrt{\frac{KT_e}{M}}$$

,where **I** and **V** are probe current and bias voltage, respectively. T_e is the electron temperature, and n_i is the ion (electron) density. The **A** is a surface area of micro Langmuir probe being taken into account the plasma sheath, **M** is the filling gas mass of ion, **k** is the Boltman constants, **e** is the charge of electron and I_{is} is the ion saturation current.[2-4]

The saturation plasma ion current flowed into micro Langmuir probe can be obtained by differentiating the probe voltage difference DV_{probe} with respect to time, which is given by[5-6]

$$I_{is} = C\frac{dV_{probe}(t)}{dt}$$

and efficiency obtained by[7-9]

$$h = \frac{pAB}{discharge\ power}$$

A : Emission Area, B : Brightness

Driving voltage with square pulse and duty ratio of 25% has been applied to a test panel under driving frequency of 35Khz. And 320V which is above firing voltage was applied for degradation.

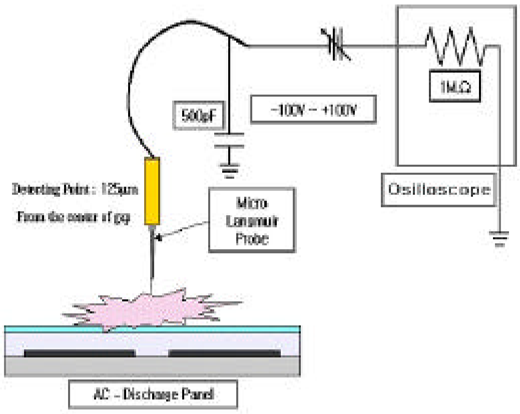

Figure 3. circuit of micro Langmuir probe

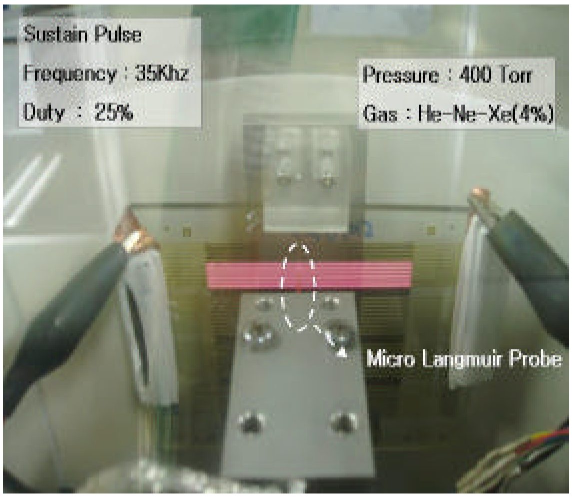

Figure 4. Experiment condition

3. Experimental Results

The electron temperature increased and the plasma density, sustain voltage, brightness, efficiency, discharge current decreased as the result of the experiment.

Figure 5 shows us that the electron temperature increases from 2eV to 5eV after discharge running time of 20 hours and saturates beyond 20 hours. The plasma density is inversely proportional to the square root of electron temperature. So the plasma density was decreased from $1.8 \times 10^{12} cm^{-3}$ to $8 \times 10^{11} cm^{-3}$ at above discharge running time.

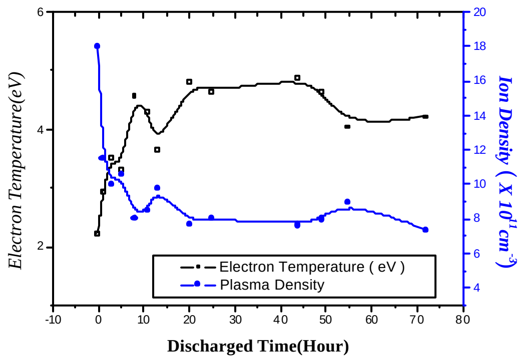

Figure 5. Plasma density and Electron Temperature

Figure 6 shows that the sustain voltage has shown to be decreased rapidly until 20hours of discharge running time and saturated beyond this time, while the brightness decreases until 40hours of discharge running time and saturates beyond this time.

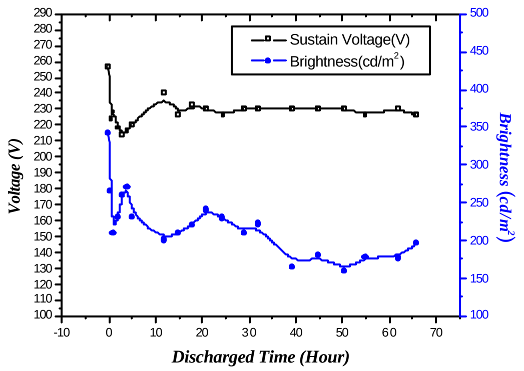

Figure 6. Sustain voltage and Brightness

The luminous efficiency has been shown to be reduced to 70% at 60hours of discharge running time in comparison with initial value of brightness.

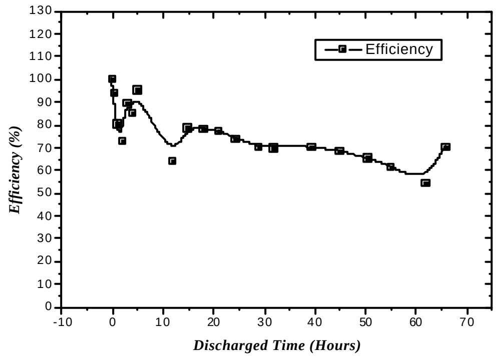

Figure 7. Efficiency

Also it is noted in this experiment that the peak of discharge currents decreases as discharge running time increases up to 60 hours. The discharge current rising times are shown to be decreased from 1.76×10^{-7}s to 1.2×10^{-7}s as discharge running time increases up to 60 hours in this experiment.

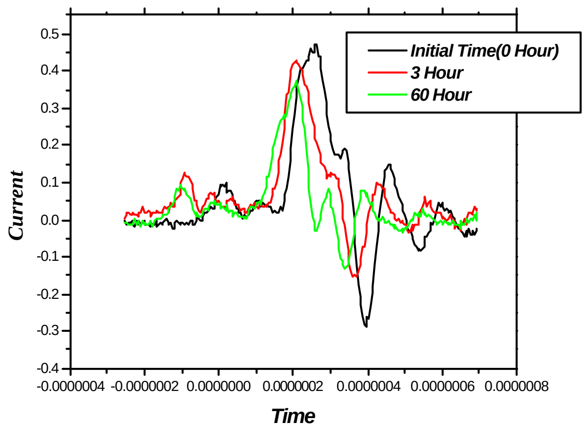

Figure 8. Discharge current

4. Conclusion

Electron temperature and plasma density in coplanar alternating-current plasma display panels (AC-PDP's) have been experimentally investigated in accordance with discharge time by a micro-probe in this experiment. In this experiment plasma ion density is decreased $1.8 \times 10^{12} cm^{-3}$ to $8 \times 10^{11} cm^{-3}$ at above discharge running time. And electron temperature increases from 2eV to 5eV after discharge running time of 20 hours and saturates beyond 20 hours. Sustain voltage decreased rapidly until 20hours of discharge running time and saturated beyond this time, while the brightness decreases until 40hours of discharge running time and saturates. The luminous efficiency has been shown to be reduced to 70% at 60hours of discharge running time in comparison with initial value of brightness. Also it is noted that the peak of discharge currents decreases from decreases as discharge running time increases up to 60 hours. The discharge current rising times are shown to be decreased from $1.76x10^{-7}$s to $1.2x10^{-7}$s as discharge running time increases up to 60 hours in this experiment

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