UV emission characteristics of Ne+N_2 gas-mixture discharges in AC Plasma Display Panel

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Abstract

The Ultra Violet(UV) emission characteristics of Neon + Nitrogen gas-mixture discharge was investigated in AC plasma display panel. The firing voltage of Ne+N_2 gas-mixture discharge increased with increasing nitrogen concentration. The UV intensity emitted from the gas discharge also increased with increasing nitrogen concentration. The UV efficiency increase with increasing N_2 partial pressure at low N_2 concentration, and then UV efficiency is saturated at high N_2 concentration.

1. Introduction

AC plasma display panel(PDP) is most promising flat panel device for being used as high definition TV screen. Conventionally, plasma display panel utilized penning gas-mixture such as neon + xenon and helium + xenon. The UV photons with 143 and 173nm wavelength emitted from xenon excited species stimulate the photoluminescence phosphor to produce the visible light. In a point of view from energy loss mechanism in plasma display panel with xenon gas-mixture discharge, the only 10% energy of discharge was used for producing UV photons and 50% of UV photon energy was not used when the visible light is emitted from the photoluminescence phosphor. Because of the inefficient lighting mechanism, the plasma display panel consumes lots of power when it is used as TV and monitor application. There were a lots of efforts to reduce the power consumption and improve the efficiency of the plasma display panel[1,2]. However, the efficiency of the plasma display panel is still low.

In this work, neon + nitrogen gas-mixture was considered to be used as discharge gas in AC plasma display panel. Nitrogen discharges emit UV photons with the range of 300~360nm. Compared to 147 and 173nm of Xenon gas-mixture, the longer wavelength UV has several merits of being used as stimulation source for photoluminescence phosphor. UV photon energy efficiency of N_2 gas-mixture discharge is higher compared to that of xenon[3,4]. Electron heating rate of Ne+N_2 gas-mixture is grater than that of Xe+Ne[5]. There is a possibility for N_2 gas-mixture to use as quantum cutting UV source. The UV emission characteristics of Ne+N_2 gas-mixture discharge were investigated in this work.

2. Experiment

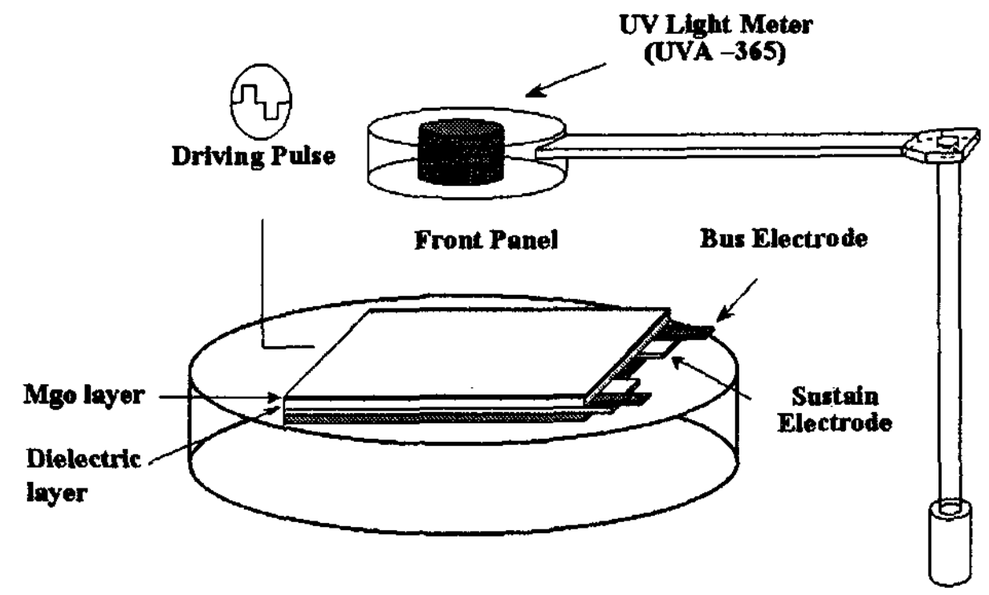

Fig 1. The schematic diagram of UV detecting system by using UVA-365 sensor

AC plasma display panel consists of two plates, front

and rear plate. In this work, the front plate was used to investigate neon + nitrogen gas-mixture discharges. On the front panel, sustain electrodes were made of Indium Tin Oxide(ITO) and patterned by photolithography. The distance between two sustain electrode was 80㎛, which was the surface discharge gap. Bus electrodes were coated on the sustain electrodes using screen print method. Next, transparent dielectric layer was applied with a 30㎛ thickness, and a 6800Å thick MgO thin film was deposited using the electron-beam method. This plate was placed in the vacuum chamber.

UV measuring sensor, UVA-365, was introduced to detect photons with 300~360nm wavelength emitted from neon + nitrogen gas-mixture discharge. The UV detecting system was also put into the vacuum chamber. Fig. 1 shows the front plate on the substrate and the UV detecting system in vacuum chamber. The pulses with 25KHz frequency and 10㎲ width were applied to the sustain electrode. The UVA-365 photo sensor has the spectral distribution as shown in Fig. 2.

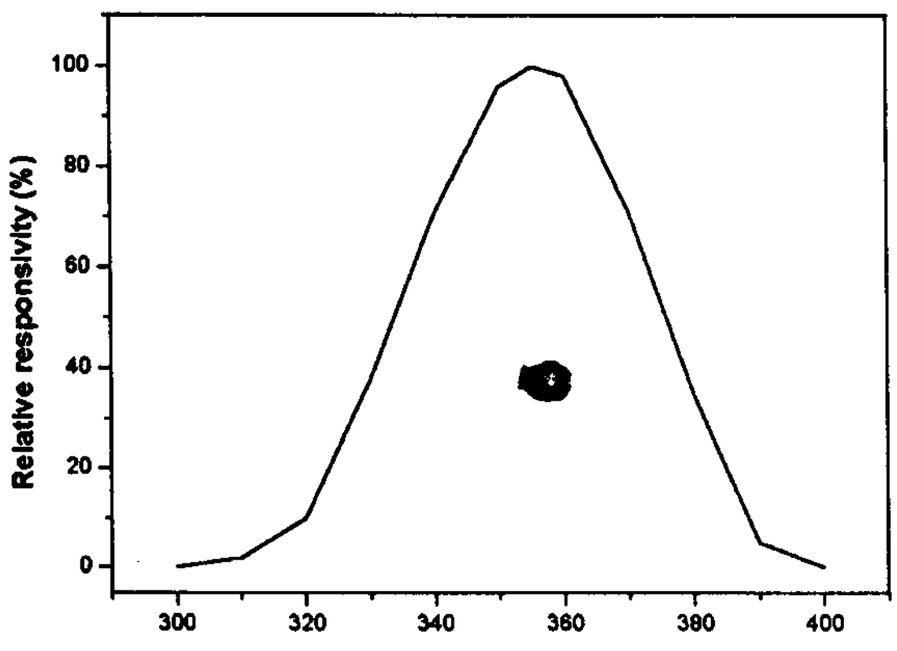

Fig 2. spectral distribution of UVA-365 sensor

Nitrogen gas discharges emit 316, 337, 358nm wavelength UV which can be measured by UV light meter as shown in Fig. 1.

3. Results and Discussion

The firing voltage between two sustain electrodes was measured. Fig. 3 shows the firing voltage as a function of gas pressure and nitrogen concentration. The firing voltage was increased with increasing gas pressure. At low nitrogen concentration, the firing voltage was not much changed. However, the firing voltage started to increase when the partial pressure of nitrogen increased.

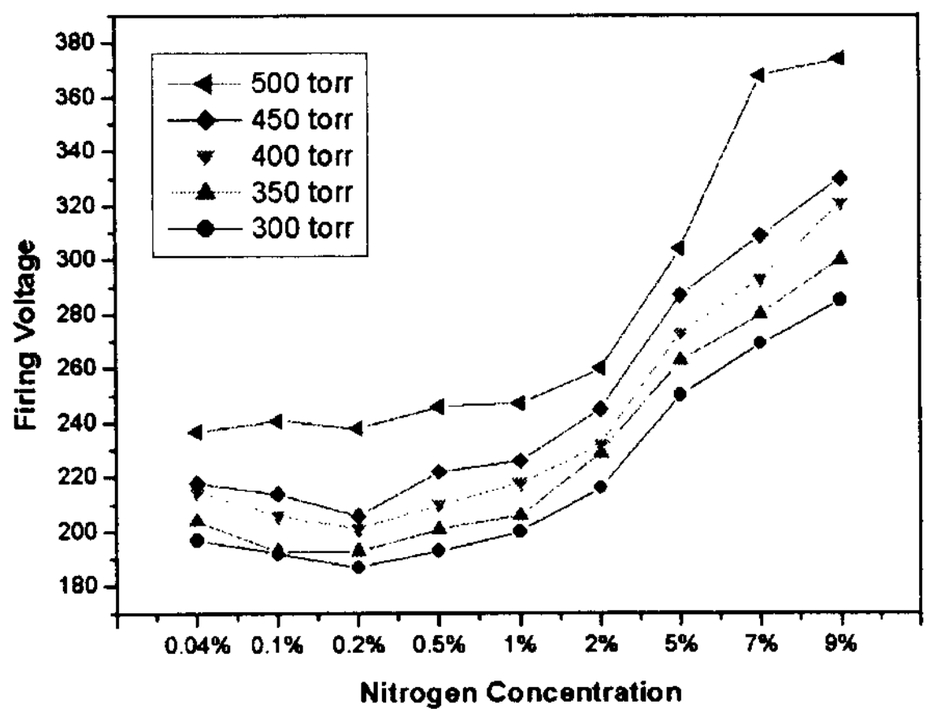

Fig 3. Firing Voltage as a function of gas pressure and N_2 concentration

Using UVA-365 photo sensor as shown in Fig. 1, the UV intensity emitted from neon + nitrogen gas-mixture discharge was detected as a function of gas pressure and nitrogen concentration.

Fig. 4 shows the UV intensity measured by UVA-365 photo sensor. The UV output linearly increased with N_2 concentration until 1%. Then, the UV intensity increased steeply and saturated.

Fig. 5 shows discharge current of Ne+N_2 gas-

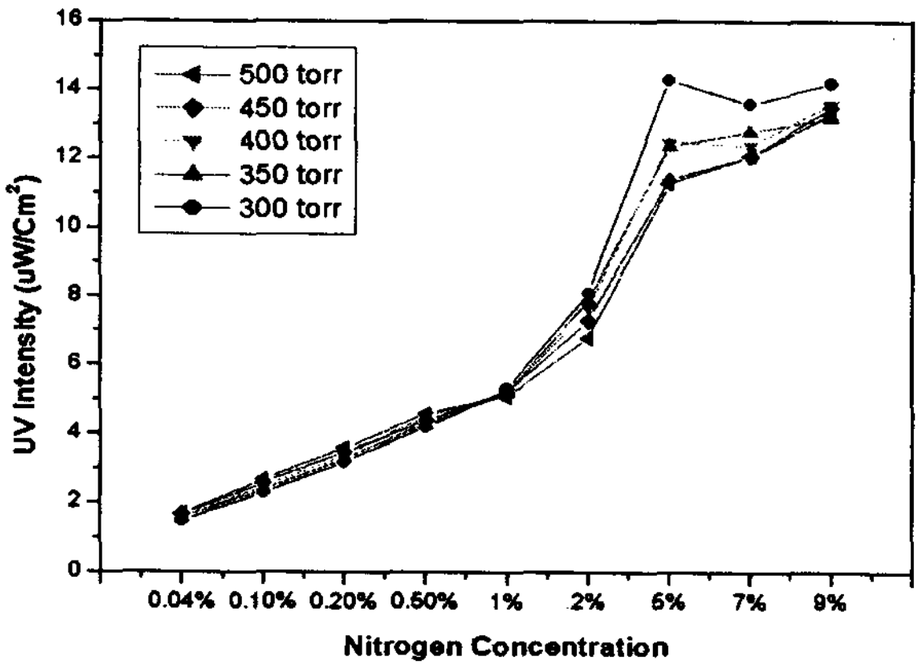

Fig 4. UV intensity as a function of gas pressure and N_2 concentration

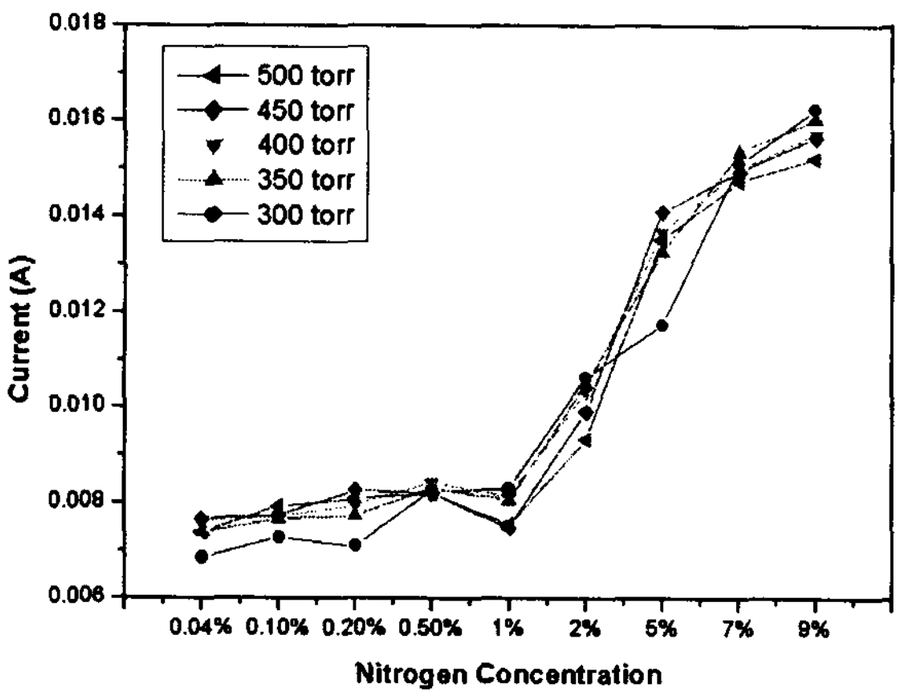

Fig 5. Current as a function of gas pressure and N_2 concentration

mixture. Discharge current of Ne+N_2 gas-mixture increases with increase of N_2 concentration. Below at 1% nitrogen concentration, the discharge current was not much changed. The discharge current started to increase from 1% N_2 concentration. The current curve was similar to the characteristics of UV output.

Finally, the UV efficiency of neon + nitrogen gas-mixture discharge was investigated. The UV efficiency can be obtain from the UV output divided by power applied to the sustain electrodes. The

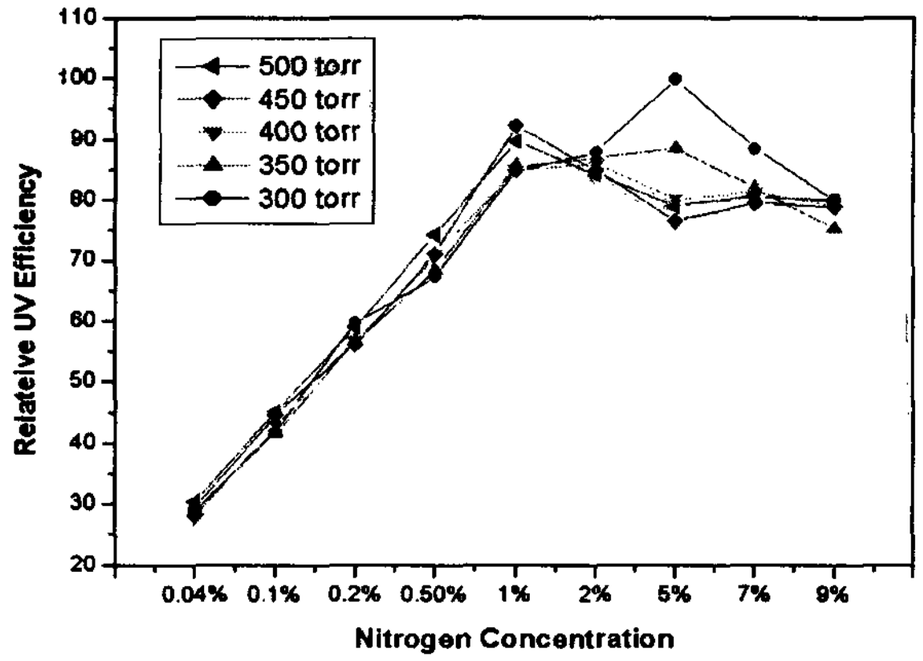

Fig 6. Relative UV efficiency as a function of gas pressure and N_2 concentration

UV efficiency linearly increased with increasing with N_2 concentration until 1%. Under the gas pressure of 450 torr, UV efficiency has its maximum value at 1% N_2 concentration. UV efficiency did not increase any more at range of 5 ~ 9% N_2 concentration.

4. Conclusion

The UV emission characteristics of Ne+N_2 gas-mixture discharge was investigated in this work. The UV intensity was linearly proportional to N_2 partial pressure at low N_2 concentration and saturated at high N_2 concentration. The efficiency UV characteristics showed the similar behavior with UV intensity at low N_2 concentration. In a point of view from UV efficiency, the best partial pressure of Ne+N_2 gas-mixture was 1%.

5. References

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