The characteristics of AC-PDPs According to binary and ternary gas mixtures of He-Ne-Xe_

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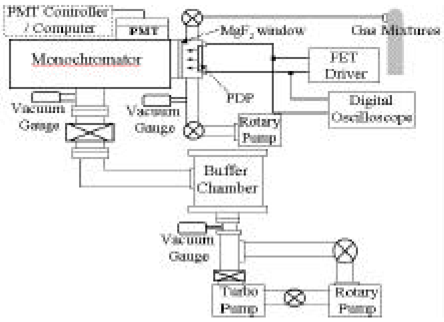
Abstract

The improvement of efficiency is the one of the most important part in AC PDPs. To achieve high efficiency, high VUV emission efficiency and High ion induces secondary electron emission coefficient are needed. We have measured the emission spectra of vacuum ultraviolet rays and ion induced secondary electron emission coefficient of MgO protective layer in surface discharge AC - PDP with binary and ternary gas mixtures. We have investigated electro-optical characteristics of AC-PDPs to optimum gas mixture for high efficient.

1. Introduction and experimental set up

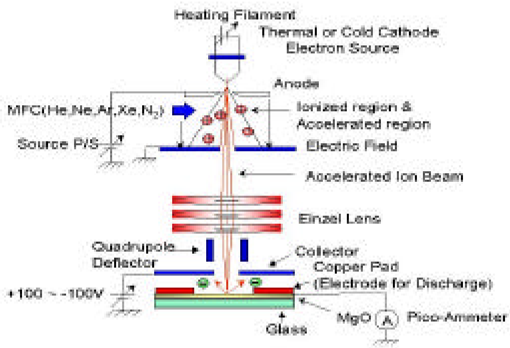
To achieve efficiency, high VUV emission efficiency [1] and ion induced secondary electron emission coefficient [2] are needed. Figure 1 shows the experimental apparatus used in the spectral measurement.

The vacuum system provides residual pressures lower than 10^{-5}Torr. The panel has been set in the demountable small vacuum chamber and it is attached by a vacuum monochromator with MgF_2 window. The filling gases used are Ne-Xe(1, 4, 7, 10 and 15%) and He(70%)-Ne-Xe(1, 4, 7, 10 and 15%) gas mixtures. The detection system consists of a photo multiplier tube and vacuum monochromator. The VUV luminous efficiency has been measured by the vacuum monochromator, and the discharge current was measured by current probe. The size of test PDP panel is a 1-inch. A square driving voltage pulse with a rising time of 150ns and a duty cycle of 25% is applied between the two sustaining electrodes. The driving frequency and pulse width are maintained 7µs at 35kHz. The width. of sustain electrodes is 300 µm and the gap between the sustain electrodes is 50 µm. The filling gas pressure has been maintained at 400Torr.



[Fig. 1] Schematic of spectral measurement experimental setup

The breakdown voltage is dependent on the gas species, the content of gas mixture, the gas pressure, and the characteristics of cathode materials. [3] One of the key elements in determining the breakdown voltage in AC-PDPs is the ion-induced secondary electron emission coefficient from MgO protective layer of the cathode. The breakdown voltage in PDP cells decreases significantly with increasing ion induced secondary electron emission. Therefore we have measured ion-induced secondary electron emission coefficient from MgO protective layer according to various gas mixtures. Figure 2 shows the schematic of γ-FIB system for measurement of secondary electron emission characteristics. The background vacuum pressure of γ -FIB is maintained at ~5 x10^{-6}Torr, whereas it is kept up by 7x10^{-5}Torr during ion beam formation. In this experiment, Ne-Xe (4, 20%) and He (70%)-Ne-Xe (4, 20%) are used for the measurement of the ion induced secondary electron emission coefficient. It is noted that the ionization energy He^+, Ne^+, and Xe^+ ions are 24.58, 21.56, and 12.13eV, respectively.



[Fig. 2] The schematic of r-FIB system

Finally, We have investigated discharge characteristics in AC-PDP with binary and ternary gas mixtures. In this experiment, the test panel is a 3.5inch, VGA class AC-PDP with a cell pitch of 1080 μm. Operating condition is square sustain pulse with 35 kHz, 25 % duty ratio in 400Torr using the Ne–Xe (4, 20%) and He-Ne-Xe (4, 20%). The MgO protective layers are deposited by electron beam evaporation method and vacuum annealed under 300℃ about 30 minutes after the deposition. The thickness of MgO thin film is 5000Å. The deposition rate is 5Å/s. We have measured firing voltage, dynamic voltage margin, luminance, and efficiency.

2. Result

The filling gas pressure has been maintained at 400 torr in the experiment. The sustaining voltage has been kept at 310, 316, 326, 330, and 350V for XMF of 1, 4, 7, 10 and 15%, respectively. The filling gas pressure has been maintained at 400torr in the experiment.

Figure 3 shows the VUV intensities of 147 nm and 173 nm versus the xenon mole fraction for binary and ternary gas mixtures of Ne-Xe and He-Ne-Xe. It is observed that

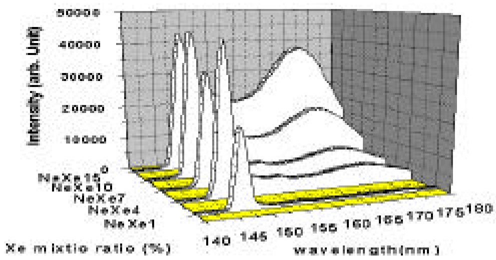


Fig 2(a)

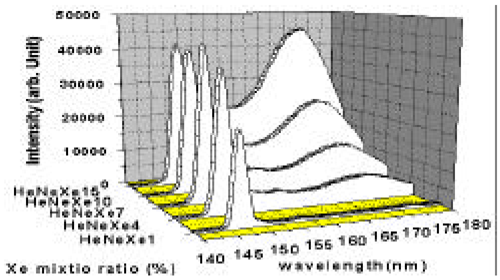
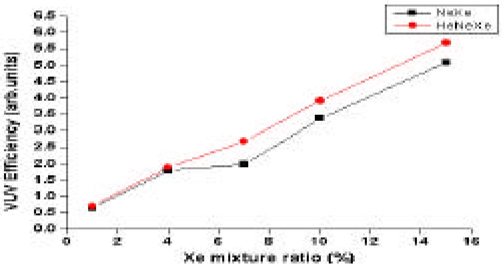


Fig. 2(b)

[Fig. 3] Vacuum ultraviolet spectral intensities for Xe mixture ratio of 1, 4, 7, 10 and 15%. at 400 torr (a) Ne-Xe (b) He(70%)-Ne-Xe

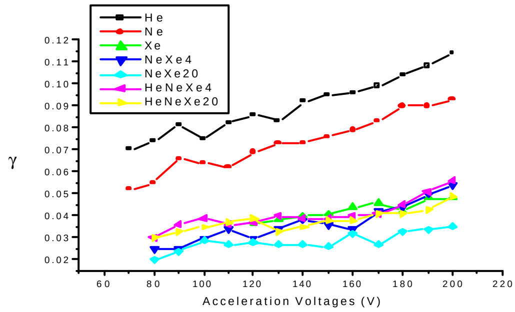
the VUV intensity of 147 nm from resonant xenon is found to increase for xenon mole fractions up to 7%, and to be saturated at xenon mole fractions beyond 7%, while the VUV 173 nm from the molecular dimer increases continuously as the xenon concentration increases[4] from 1% to 15%. Therefore, It is noted that the VUV 173 nm emitted from the excited molecular dimers still increases with the increasing XMF in this experiment because the dimers scales linearly with the xenon density and these are comparable to those of VUV 147nm under the binary and ternary gas mixtures of Ne-Xe and He-Ne-Xe in this experiment.



[Fig. 4] Vacuum ultraviolet luminous efficiency including both 147 nm and 173 nm versus xenon mole fractions on Ne-Xe and He (70%)-Ne-Xe gas mixtures at 400 torr.

Figure 4 shows the total VUV luminous efficiency including both 147 nm and 173 nm versus XMF. The relative VUV efficiency has been obtained by dividing the integrated VUV intensities from 140 nm to 180nm by the discharge power. [4] It is found that luminous efficiency of ternary gas mixture, He-Ne-Xe, is shown to be much higher, by an amount of 25%, than that of binary gas mixture of Ne-Xe for high XMF greater than 7% in this experiment.

The electrical discharge in the PDP cells is carried out in a gas mixture, to reduce the breakdown voltage in the PDP cells. Therefore we have measured the secondary electron emission in terms of mixed gases. Figure 5 shows experimental data for the secondary electron emission coefficient versus the acceleration voltage for Ne-Xe (4, 20%) and He (70%)-Ne-Xe (4, 20%). According to the Auger neutralization, the secondary electron emission coefficient γ increases with the increasing value of the ionization energy of gas neutrals. The ionization energies of helium, neon and xenon are 24.58, 21.56 and 12.23eV, respectively. In gas mixture, the number of xenon atoms is much lower than that of the helium and neon atoms, coefficient γ for a small value of the mole fraction is very close to that for the xenon-only gas. We except that the plasma in the PDP cells are mostly xenon plasma. Therefore the secondary electron emission coefficient is almost the same as that of the xenon-only gas. But coefficient γ is dependent on the gas species .



[Fig. 5] secondary electron emission coefficient vs the acceleration voltage for Ne-Xe (4, 20%) and He (70%)-Ne-Xe (4, 20%)

Table 1 shows the characteristics of discharge in AC-PDP test panel with binary and ternary gas mixtures, respectively. We have instigated firing voltage, sustain voltage, luminance and efficiency. In this result, the firing and sustain voltage of ternary gas mixture or low XMF is shown to be much lower than that of binary gas mixture or high XMF, and the luminance efficiency of ternary gas mixture, He-Ne-Xe and High XMF, is shown to be much higher than that of binary gas mixture of Ne-Xe and low XMF. Therefore we have confirmed the preceding results.

		Ne-Xe 4%	Ne-Xe 20%	He-Ne-Xe 4%	He-Ne-Xe 20%
Vf [V]		283.3	332.3	234.7	316.3
Vsmax [V]		229.7	254	181.7	266
Vsmin [V]		175.3	190.3	147.7	232.3
Luminance	**Red**	182	452.3	415.3	990.75
	Blue	190.3	486.7	448.3	1013.5
	Green	185	450	422	933.75
	Average	185.8	463	428.5	979.3
Relative Efficiency		1	1.9	3.3	4.5

[Table. 1] The characteristics of discharge in AC PDP test panel with binary and ternary gas mixtures.

3. Conclusion

We have obtained various results about characteristics of AC-PDP according to binary and ternary gas mixture of He, Ne, Xe. We have conformed luminance efficiency of ternary gas mixture, He-Ne-Xe and high XMF, is shown to be much higher than that of binary gas mixture of Ne-Xe and low XMF. And we also have confirmed the test panel with He-Ne-Xe 4% whose ion induced secondary electron coefficient is the highest value among the mixed gases, has the lowest firing voltage.

4. Reference

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