Influence of gas mixture He-Ne-Xe on the vacuum ultraviolet intensity in ac-PDPs.

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Abstract

The improvement of luminance and luminous efficiency is the one of the most important parts in AC-PDPs. To achieve high luminance and luminous efficiency, high VUV emission efficiency is needed. We measured the emission spectra of the vacuum ultraviolet(VUV) rays in surface discharge AC-PDP with ternary gas mixture of He-Ne-Xe. The influence of He-Ne-Xe gas-mixture ratio on excited Xe^{*} resonant atoms and Xe_2^{*} dimers has been investigated. It is found that luminous efficiency of ternary gas mixture, He-Ne-Xe, is shown to be much higher than that of binary gas mixture of Ne-Xe. For improving discharge luminous efficiency, we have studied VUV emission characteristics of ternary gas mixture, He(50%)-Ne-Xe and He(70%)-Ne-Xe with Xe concentration and filling gas pressure.

1. Introduction

The surface discharge alternating current plasma display panels (ac-PDPs) utilizes the photoluminescence phenomena of phosphors excited by vacuum ultraviolet (VUV) rays from xenon in the penning mixture gas(Fig. 1).
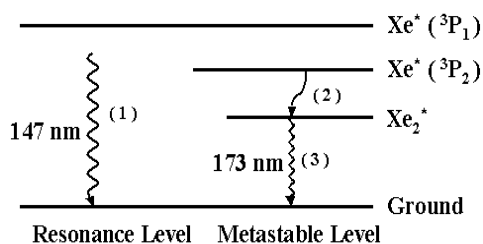

Fig. 1. Energy level of vacuum ultraviolet line

The improvement of luminous efficiency is one of the most important parts for having the PDPs as the leader of the large flat panel display devices. But there are several problems to be solved in ac-PDPs, that is, low discharge luminous efficiency, high price, image sticking and so on. One of the major factors for improving the discharge luminous efficiency is the emission characteristics of VUV rays from xenon[1] .
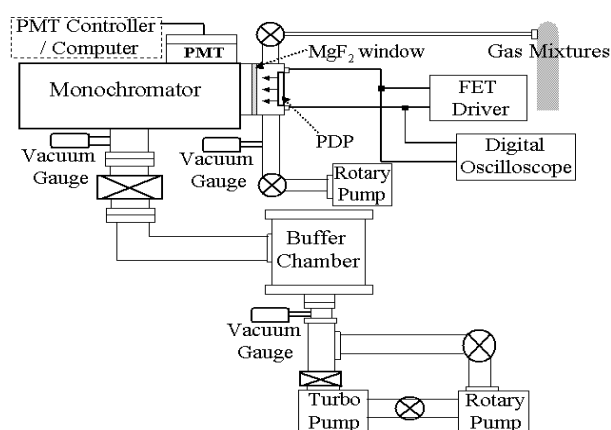
2. Experiments and results

Fig. 2. Schematic of experimental setup

Figure 2 shows the experimental apparatus used in the spectral measurement consists of a vacuum monochromator, vacuum chambers, driving circuits, gas filling systems, and the detection systems. 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 panel for this experiment is a 1-inch. The width of the sustain electrodes is 300 μm and the gap between the sustain electrodes is 50 μm, respectively. The front glass in ac-PDPs has been used in the measurement of VUV emission intensity throughout the experiment. The filling gases are used He(50, 70%)-Ne-Xe(1, 4, 7, 10, 15%) gas mixtures. The detection system consists of a PMT(photo multiplier tube) and vacuum monochromator. The VUV intensity has been measured by the vacuum monochromator and the discharge current was measured by current probe. A square driving voltage pulse with a rising time of 200ns and a duty cycle of 25% is applied between the two sustaining electrodes. The driving frequency and pulse width are maintained 7μs at 35kHz, respectively, in this experiment. The filling gas pressure has been maintained at 200 Torr, 300 Torr, 400 Torr and 500 Torr in this experiment. It is measured that VUV emission intensities of He(50, 70%)-Ne-Xe(1, 4, 7, 10, 15%). First above all we recovered and reconfirm last experimental results about the ternary gas mixture of He(70%)-Ne-Xe(%).
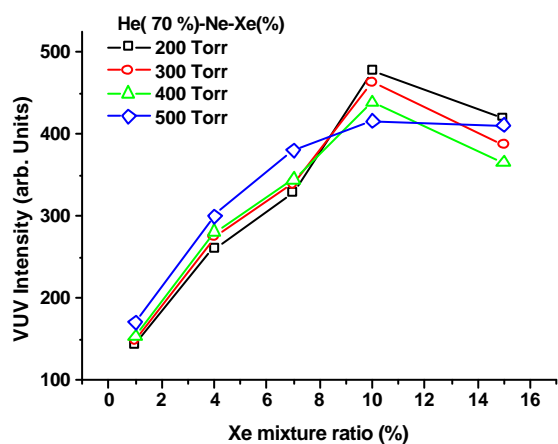

Fig. 3. VUV 147 nm intensity versus XMF of He(70%)-Ne-Xe(%) at 200, 300, 400 and 500 Torr

Figure 3 shows the VUV intensity of 147 nm versus the xenon mole fraction for ternary gas mixture of He(70%)-Ne-Xe for several gas pressures 200, 300,

400 and 500 Torr. It is observed that the VUV intensity of 147 nm from resonant xenon increases up to 10% of xenon content and saturates over 10%.
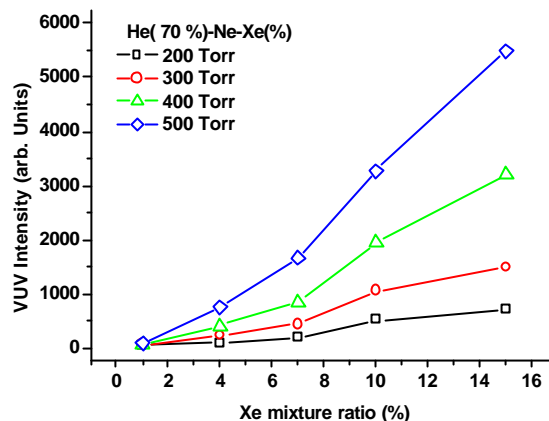

Fig. 4. VUV 173 nm intensity versus XMF of He(70%)-Ne-Xe(%) at 200, 300, 400 and 500 Torr

Figure 4 shows the VUV intensity of 173 nm versus the xenon mole fraction for ternary gas mixture of He(70%)-Ne-Xe for several gas pressures 200, 300, 400 and 500 Torr. It is observed that the VUV intensity of 173 nm from the molecular dimer increase continuously as the xenon concentration increase [2] from 1% to 15% under these pressure ranges. While the ratio of molecular dimer emission 173 nm to resonant emission 147 nm increases rapidly due to density increase of molecular dimer Xe_2^* throughout the three-body collision process [3-7] for the xenon concentration beyond 7% for these pressure ranges from 200 Torr to 500 Torr. The intensity of VUV 147 nm emitted from the resonant atoms saturates in part by reduction of mean free path of electrons and in part by increased self-shielding of resonance radiation trapping [8,9] for XMF beyond 10%. The intensity of VUV 173 nm emitted from the excited molecular dimers still increases with the increasing Xe contents. Throughout last experiment we found that total luminous efficiency of ternary gas mixture, He(70%)-Ne-Xe is much higher than the binary mixing gas, Ne-Xe. We suggested that the ternary gas mixture of He(70%)-Ne-Xe for Xe concentration of 15% and filling gas pressure of 400 Torr, can be suggested as the one of the candidates of the total VUV emission intensity[10,11]. But they still need further improvements. To find the optimal gas mixture ratio

for improving VUV luminous efficiency, we also measured VUV intensities of 147 nm and 173 nm according to the xenon contents for ternary gas mixture of He(50%)-Ne-Xe(%) for several gas pressure 200, 300, 400 and 500 Torr. It is found that higher xenon concentration leads to the increase in the operating voltage in this experiment.
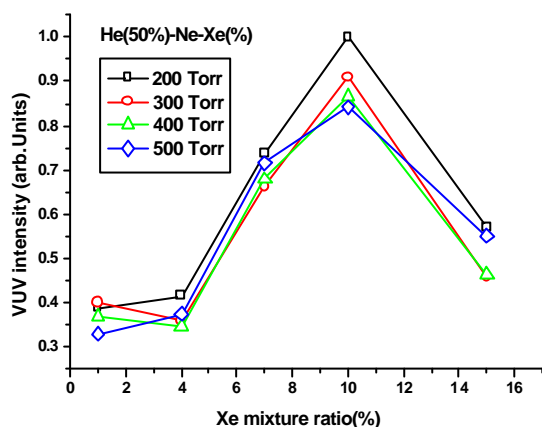

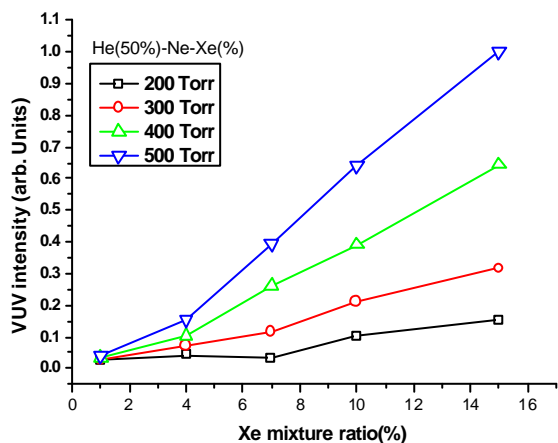**Fig. 5. VUV 147 nm intensity versus XMF of He(50%)-Ne-Xe(%) at 200, 300, 400 and 500 Torr**

Fig. 6. VUV 173 nm intensity versus XMF of He(50%)-Ne-Xe(%) at 200, 300, 400 and 500 Torr

Figure 5 and 6 shows the VUV 147 nm and 173 nm emission versus the xenon mole fraction for ternary gas mixture of He(50%)-Ne-Xe for several gas pressures 200, 300, 400 and 500 Torr. The VUV emission characteristics of He(50%)-Ne-Xe show similar to He(70%)-Ne-Xe tendency. The VUV

intensity of 147 nm increases up to 10% of xenon mole fraction and decreases over 10%. But VUV emission tendency according to pressure is unlike to He(70%)-Ne-Xe. The emission property of 173 nm VUV from He(50%)-Ne-Xe(%) is nearly like to He(70%)-Ne-Xe .The VUV 173 nm emission from the excited molecular dimers also increases drastically with an increasing value of the filling gas pressure and Xe concentration.

3. Conclusion

The gas mixture ratio is major factor to improve the luminous efficiency. And to achieve the high luminous efficiency, high VUV emission efficiency is needed. Currently ternary gas(He-Ne-Xe) is being researched actively to improve luminous efficiency. Throughout last experiment we found that total luminous efficiency of ternary gas mixture, He(70%)-Ne-Xe is much higher than the binary mixing gas, Ne-Xe. We suggested that the ternary gas mixture, He(70%)-Ne-Xe for Xe concentration of 15% and filling gas pressure of 400 Torr, can be suggested as the one of the candidates of the total VUV emission intensity. But they still need further improvements. To find the optimal gas mixture ratio for improving VUV luminous efficiency, we also measured VUV intensities of 147 nm and 173 nm according to the xenon contents for ternary gas mixture of He(50%)-Ne-Xe(%) for several gas pressure 200, 300, 400 and 500 Torr. The VUV emission characteristics of He(50%)-Ne-Xe showed similar to He(70%)-Ne-Xe tendency. But the little change of gas mixing condition has an influence on VUV emission characteristics. Therefore we will study continuously the VUV emission characteristics and VUV efficiency of the 147 nm from the resonant atoms and the 173 nm from the excited molecular about the ternary gas mixture He(70, 50%)-Ne-Xe. And we will study optimal gas mixture for improving the discharge efficiency.

4. References

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