Binary and ternary gas mixtures of He-Ne-Xe for improvement of vacuum ultraviolet luminous efficiency in ac-PDPs.

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Abstract

The improvement of luminance and luminous efficiency is the one of the most important part in AC-PDPs. To achieve high luminance and luminous efficiency, high VUV emission efficiency is needed. We measured the emission spectra of vacuum ultraviolet(VUV) rays in surface discharge AC-PDP with binary and ternary gas mixtures of Ne-Xe and 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.*

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. 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 xeon.[1] It is noted that xenon's VUV emission of 147 nm from Xe^* resonant atoms, with its energy level of 8.44 eV, and 173 nm from molecular dimer Xe_2^* with its energy level of 7.17 eV, are closely related to IR emissions of 828 and 823 nm, respectively under various xenon mole fractions(XMF).[1-3]

2. Experimental

Figure 1 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 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.

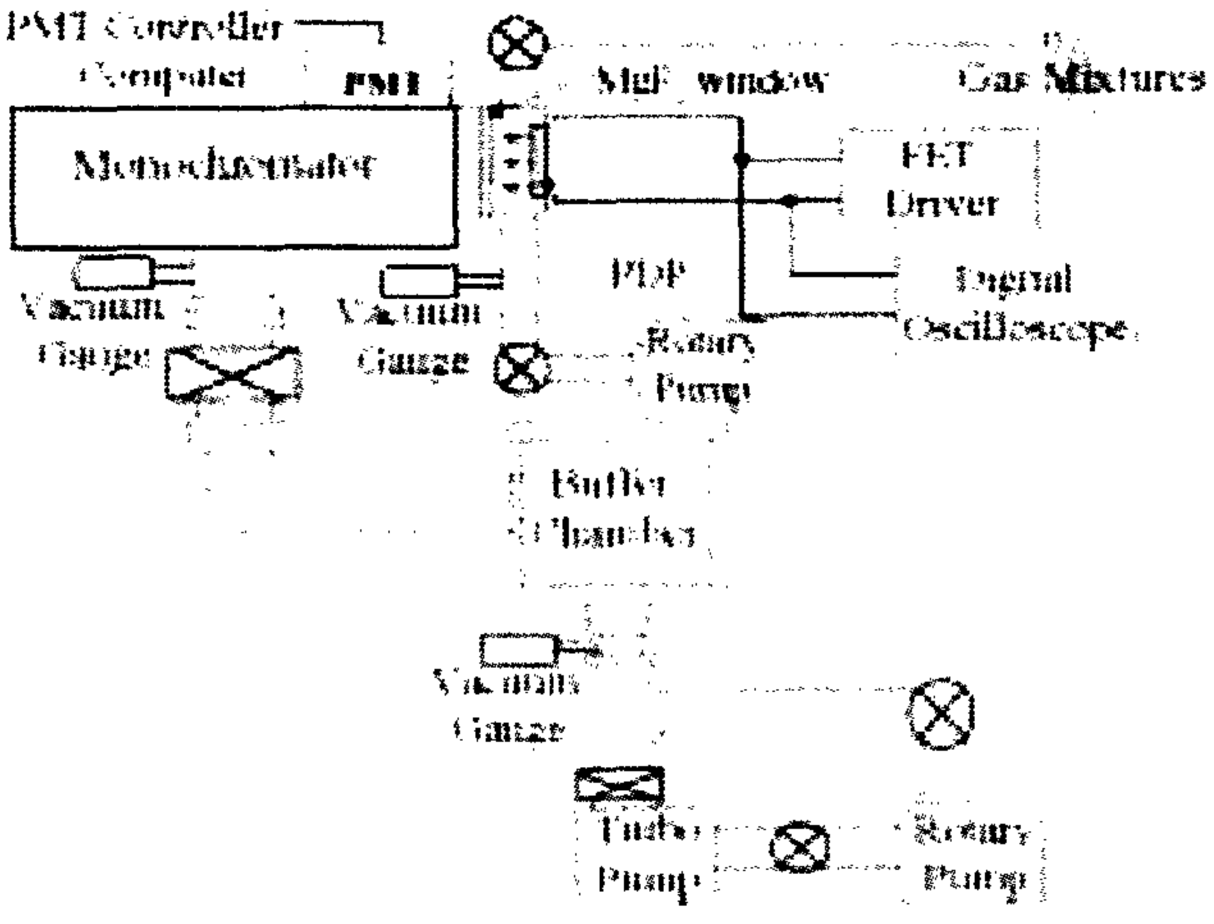

Fig. 1. Schematic of experimental setup.

The detection system consists of a PMT(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 for this experiment is an 1-inch. 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 width of sustain electrodes is 300 μm and the gap between the sustain electrodes is 50 μm.

3. Results and discussion

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

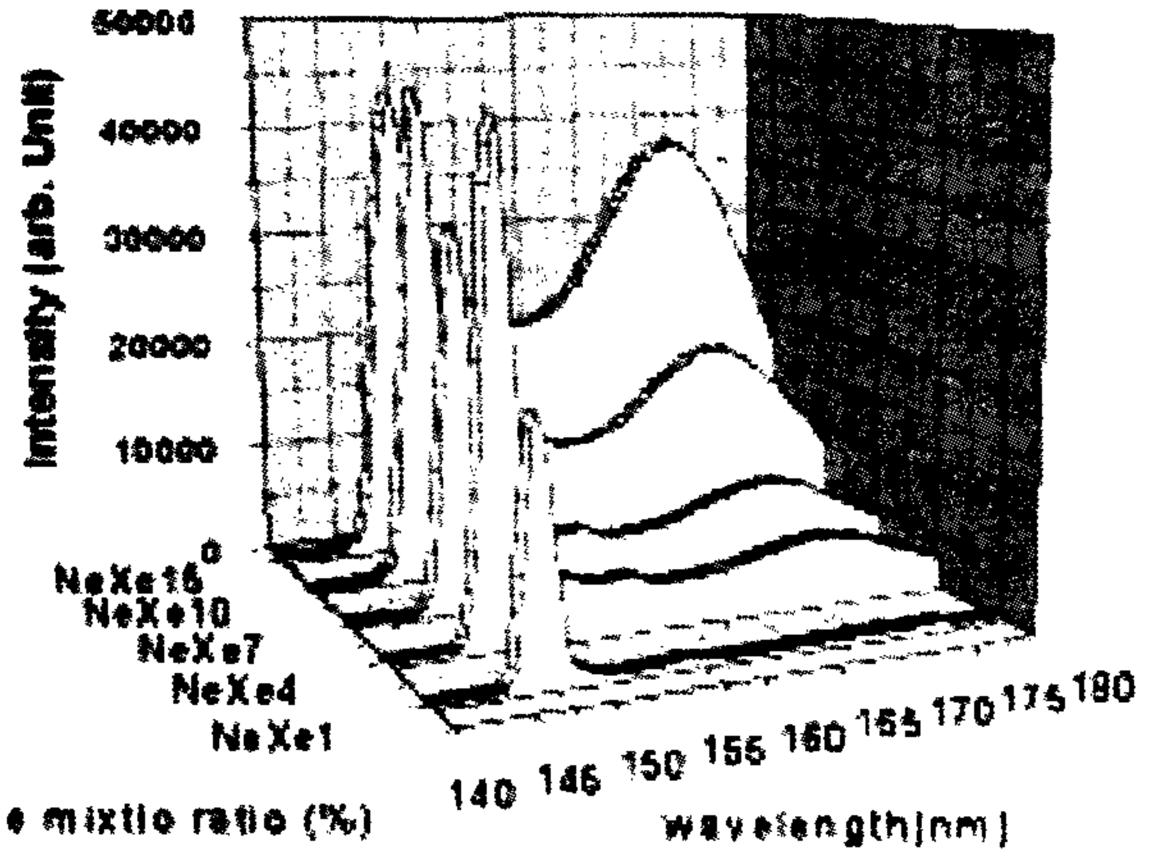

Fig 2(a)

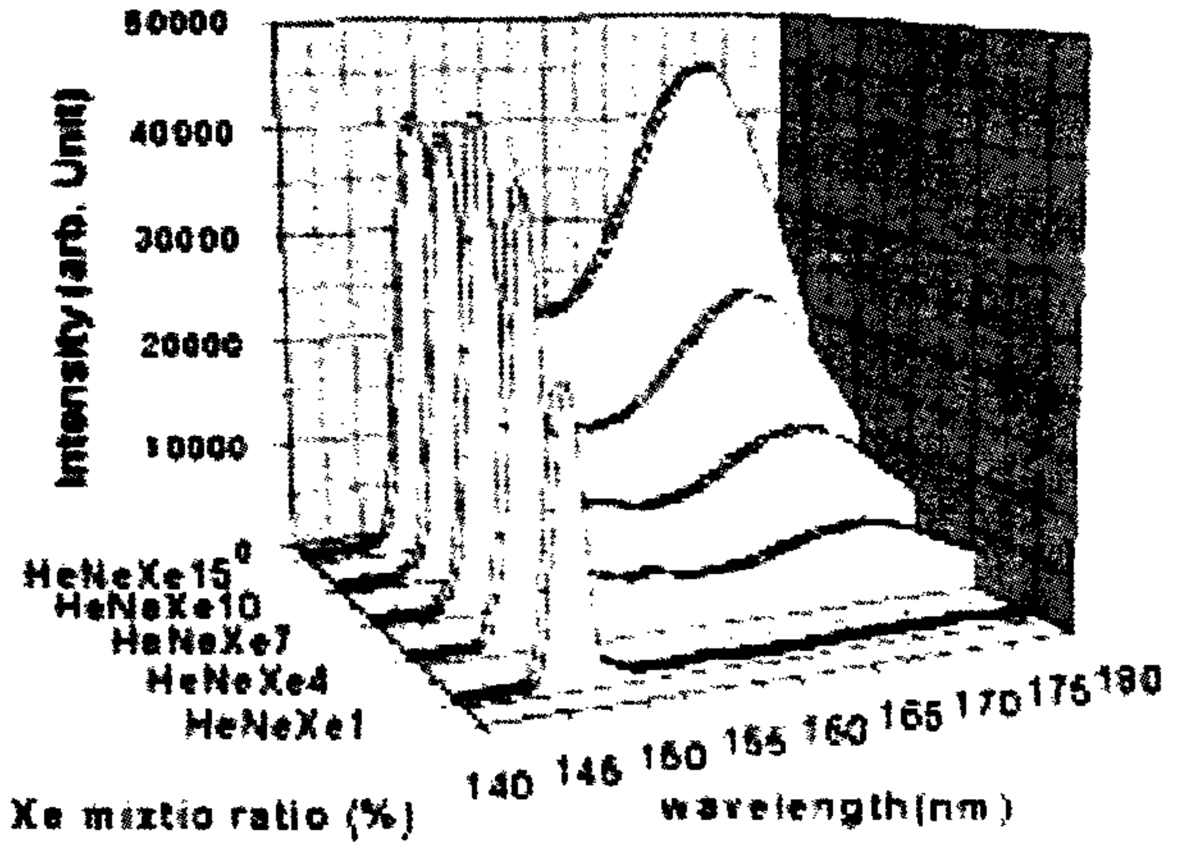

Fig. 2(b)

Fig. 2.Vacuum ultraviolet spectral intensities for Xe mixture ratio of 1%,4%,7%,10% and 15%. (a) Ne-Xe at 400 torr. (b) He(70%)-Ne-Xe at 400 torr.

Figure 1 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 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, 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 [5-9] for the xenon concentration beyond 7%. 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.

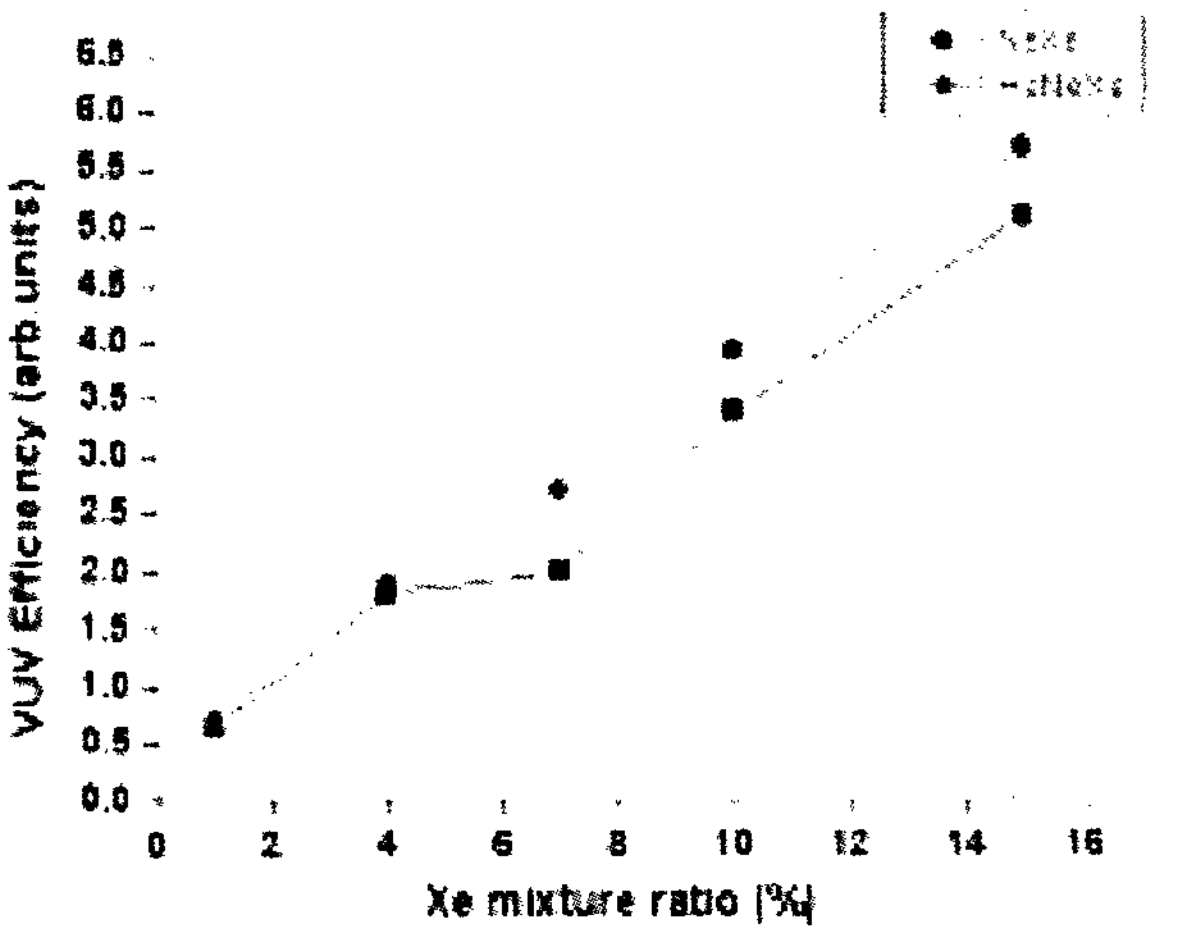

Fig. 2. Vacuum ultraviolet luminous efficiency including both 147 nm and 173 nm versus xenon mole fractions on Ne-Xe and He(70%)-Ne-Xe gas mixtures at 400 torr.

Figure 2 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.

4. Conclusion

The influence of binary and ternary gas mixtures of He-Ne-Xe for improvement of vacuum ultraviolet luminous efficiency in ac-PDPs has been investigated. To achieve high luminance and luminous efficiency, high VUV emission efficiency is needed. It is noted that the VUV 173 nm emitted from the excited molecular dimers still increases with the increasing XMF because the dimers scales linearly with the xenon density and these are comparable to those of VUV 147 nm under the binary and ternary gas mixtures of Ne-Xe and He-Ne-Xe. Moreover, the VUV 173 nm emitted from excited molecular dimers of ternary gas mixtures, He-Ne-Xe, are much higher than that of binary gas mixtures, Ne-Xe, with the increasing XMF. The 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.

5. References

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