The influence of Ne-Xe gas mixture ratio on vacuum Ultraviolet and infrared line in AC-PDP

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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) and infrared(IR) rays in surface discharge AC-PDP with Ne-Xe mixture gas. The influence of Ne-Xe gas-mixture ratio on resonance state Xe(3p₁) and exited state Xe* (3p₂) has been investigated. It is found that the intensity of VUV 147nm emission is proportional to that of the IR 828 nm emission, and the VUV 173nm emission is roughly proportional to that of the IR 823nm emission. The electron temperature and plasma density have been experimentally measured from the center of sustaining electrode gap by a micro Langmuir probe in AC-PDPs. The plasma density from the center of sustaining electrode gap are shown to be maximum value of* 9×10^{11} cm^{-3}*, where the electron temperature is about 1.6 eV in this experiment*

1. Introduction

the surface discharge AC-PDP (alternating current plasma display panels) utilizes the photoluminescence phenomena of phosphors excited by VUV(Vacuum Ultra Violet) rays from xenon in the Penning mixture gas. The luminous efficiency improvement is one of the most important issues to make PDP into leader of large flat panel display device. The present AC-PDPs showed very little change, for example, cells structure, pressure and mixing condition of rare gas, phosphor, and MgO, and driving scheme, with its panel luminance efficiency staying at 1.5 lm/W level in 40" class. [4,5] In order to improve the discharge luminous efficiency for AC-PDP, the emission characteristics of VUV rays from xenon is important for color AC-PDPs. Generally speaking, the intensity of Xe 828nm emission is proportional to that of the Xe 147nm vacuum ultraviolet which excites the phosphor[1-3]. At first, we observed xenon 823 and 828nm infrared light which relates to VUV 173nm and 147nm emission, respectively, and we measured the 147nm from $Xe(3p_1)$ resonance emission and the 173 nm from molecular dimer $Xe2^*(3p_2)$ for Ne-Xe mixture gas using an vacuum monochromator.

2. Basic Concept

The experimental apparatus used in the spectral measurement is shown schematically in Figure 1. The system consists of a vacuum monochromator, vacuum chamber, driving circuits and gas filling systems. The vacuum system has been provided with residual pressures lower than 10^{-5} Torr. The panel has been set in the demountable small vacuum chamber and it is attached by vacuum monochromator.

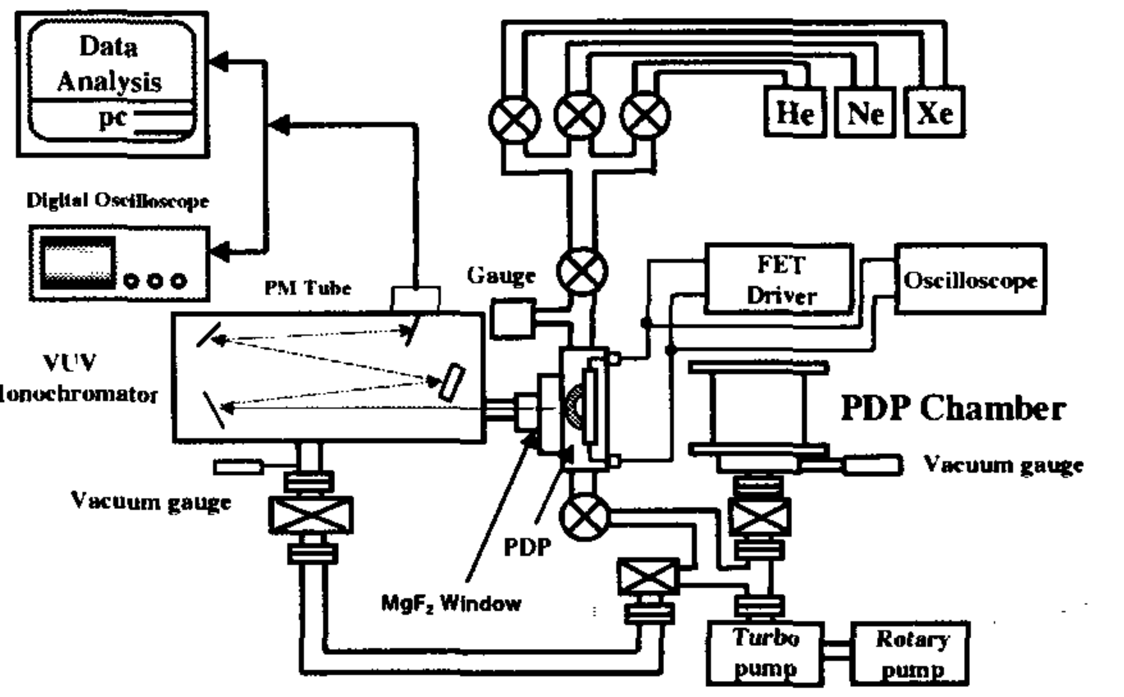

Fig. 1. Measurement apparatus of vacuum monochromator

The filling gases used are Ne + Xe (1, 2, 4, 7, 10 %) mixture gases. The detection system consists of a photomultiplier and data analysis PC. The VUV and IR luminosity have been measured by the vacuum monochromator, and the discharge current was measured by current probe. Luminous efficiency has been obtained relatively by dividing the luminosity by discharge power. The driving frequency and pulse

3. Experimental Results and Discussions

The spectral emission from AC-PDP cells are shown in Fig. 2. The red, green, blue phosphors emit their respective photoluminescences, 585 nm and 703.2 nm lines are from Ne, and IR lines of 823 nm and 828 nm are associated with Xe_*^2 dimer molecules and resonance Xe atoms, respectively. Figure 3 shows the VUV 147 and 173nm emission as a function of gas pressure 200, 400 and 600 Torr of Ne +Xe(4%) gas mixture. We can find two peak points, one is 147nm peak part and the other is 173nm peak part. The luminous intensity of 147nm is generally higher than that of 173nm. The luminance of 147nm decreases as being higher pressure. The main reason is thought to be the increase of self-absorbing phenomenon. As pressure increases, the probability of collision between excited Xe* and electron increases, so that luminance and luminous efficiency of 147nm decreases. The luminous intensity of 173nm increases at higher pressure because of easier dimer formation of Xe_*^2 than at low pressure. So the density of Xe_*^2 increases and luminance and luminous efficiency of 173 nm increase.

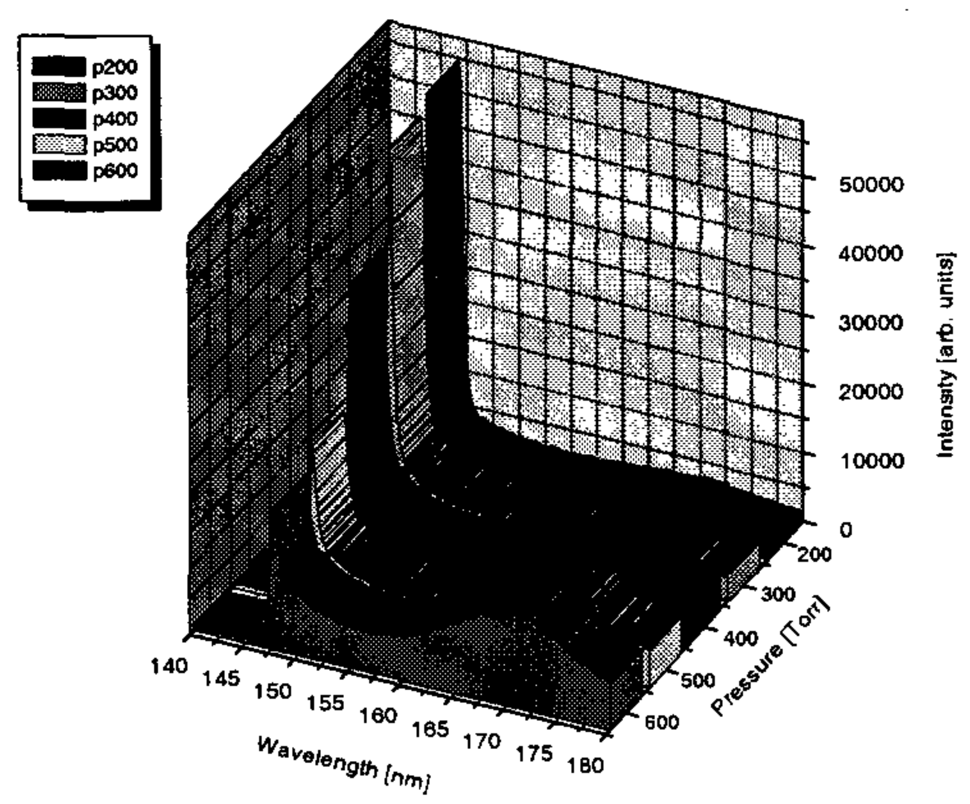

Fig. 3. Vacuum ultraviolet as a function gas pressure

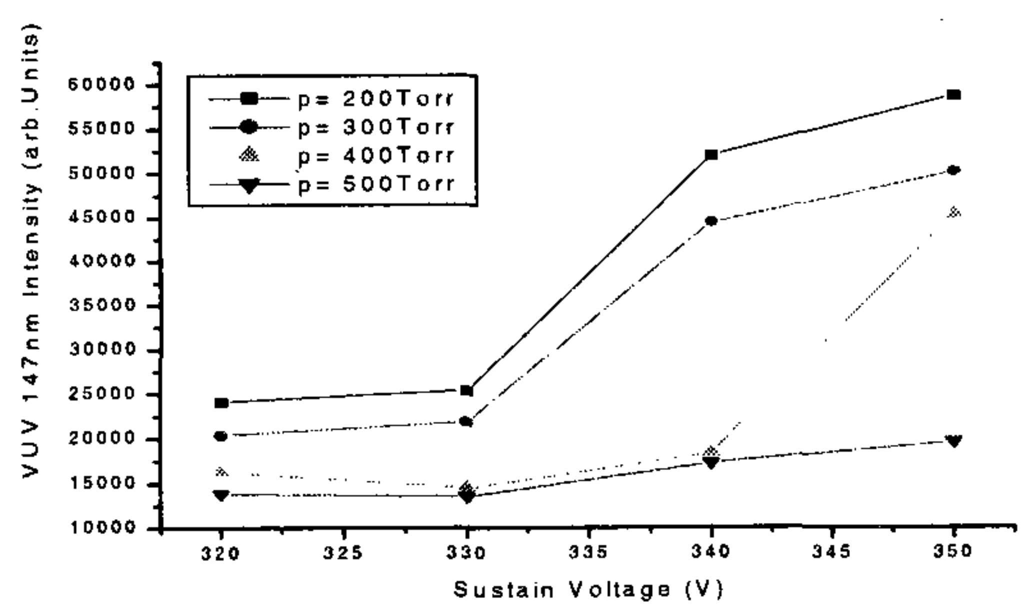

Fig. 4. The dependence of VUV 147 nm line versus sustaining voltage

Figure 4 shows the dependence of VUV 147 nm emission on sustaining voltage for various gas pressure. We see that the luminance intensity of 147 nm decreases as being higher pressure. Moreover, it is noted that the luminance intensity of 147 nm emission increases with sustaining voltage. Figure 5 shows the dependence of IR 828 nm line on sustaining voltage for various gas pressure. Also we see that the luminance intensity of 828nm decreases as being higher pressure. Moreover it is noted that the luminance intensity of 828 nm increases with sustaining voltage. It is noted that the Xe atoms emitting IR 828 nm are indicating sign of the Xe*($3p_1$) exited state Xe atoms that emits VUV 147 nm line.[7]

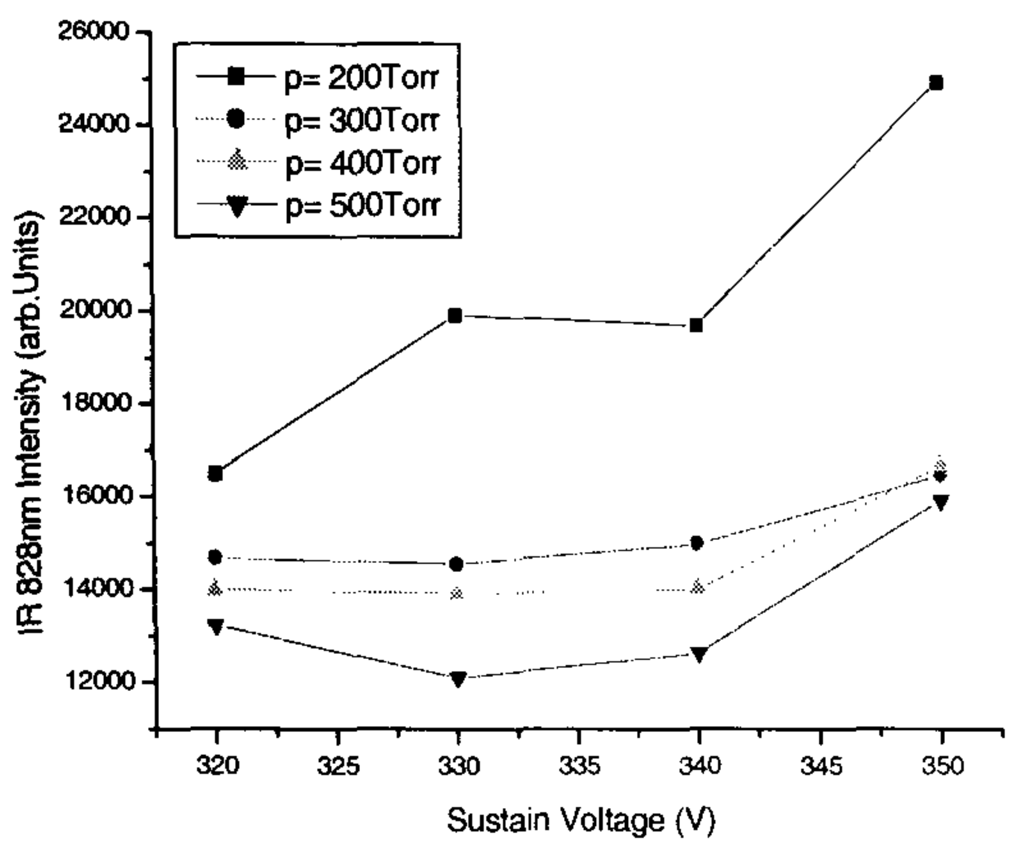

Fig. 5. The dependence of IR 828 nm line vs sustaining voltage

Figure 6 shows the dependence of VUV 173 nm on sustaining voltage for various gas pressure. We see that the luminance intensity of 173 nm increases as being higher pressure. Moreover, it is noted that the luminance intensity of 173 nm increases with sustaining voltage.

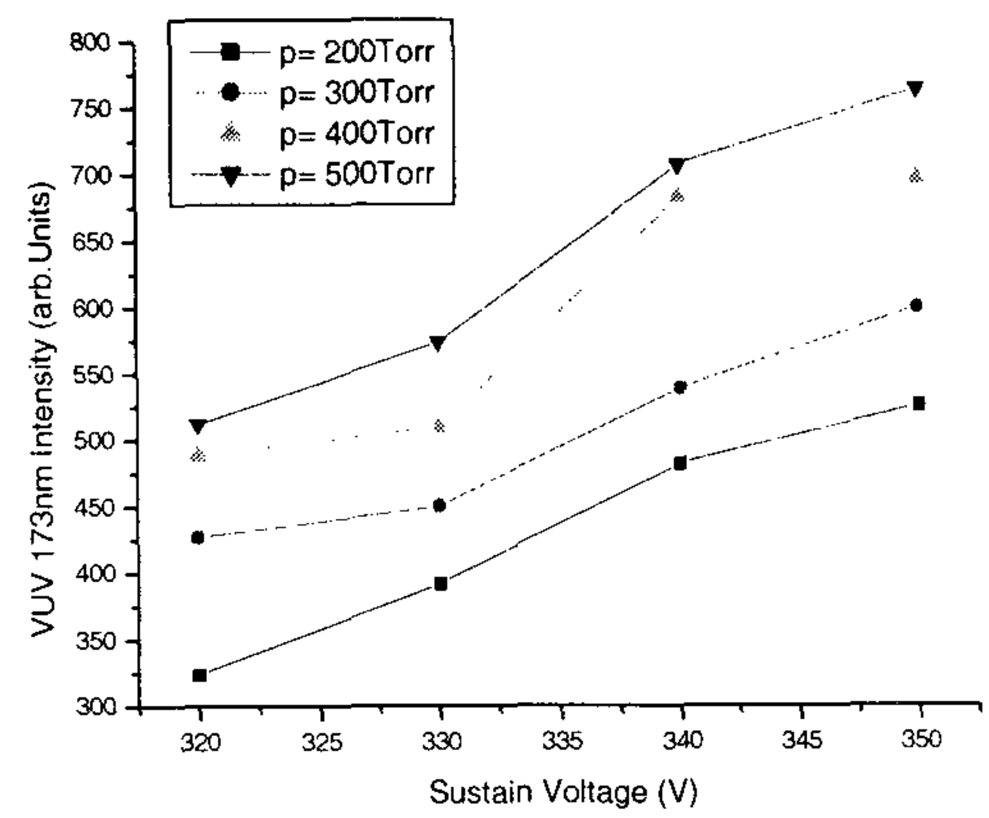

Fig. 6. The dependence of VUV 173 nm line versus sustaining voltage

Figure 7 shows the dependence of IR 823 nm line on sustaining voltage for various gas pressure. The luminance intensity of 823 nm is highest for gas pressure 500 Torr and successively low for 400, 300, and 200 Torr. Moreover, it is noted that the luminance intensity of 823 nm increases with sustaining voltage. It is noted that the Xe atoms emitting IR 823 nm are indicating sign of the Xe*($3p_2$) excited state Xe atoms that emits VUV 173 nm line. The driving frequency and pulse width are maintained to be 100 kHz and 8μs, respectively, in this experiment. It is noted that the luminous efficiency is found to be saturated for high Xe gas mixture ratio greater than 7 %.

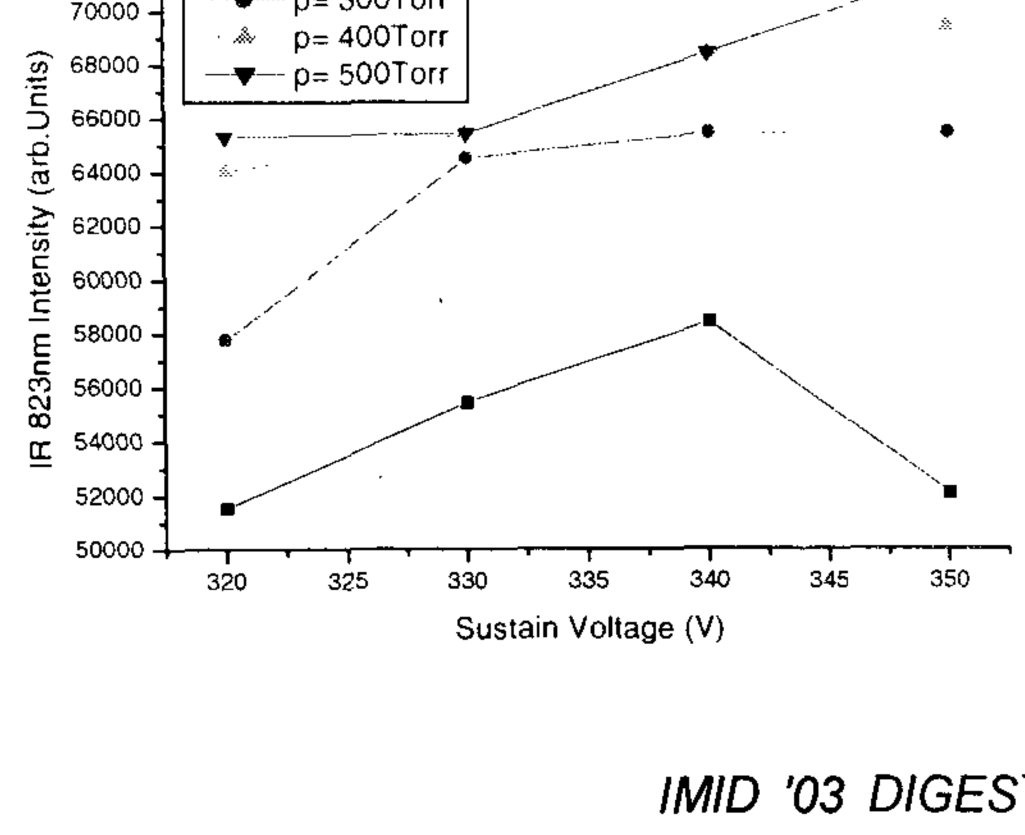

Fig. 7. The dependence of IR 823 nm line versus sustaining voltage

This saturation characteristic with increasing Xe gas mixture ratio has been related to the plasma saturation. [8,9,10]

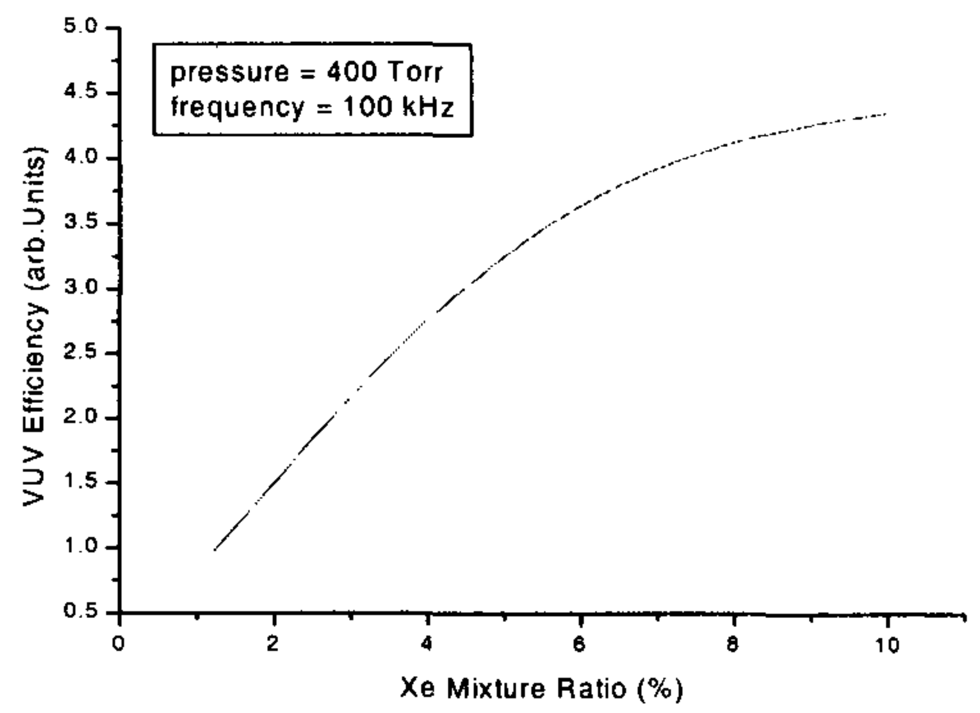

Fig. 8. The VUV efficiency versus Xe gas mixture ratio

Figure 9 shows the dependence of IR luminous efficiency on Xe gas mixture ratio under gas pressure of 400 Torr. The IR efficiency is increased as Xe concentration is increased. It is noted that the IR luminous efficiency is found to be saturated for high Xe gas mixture ratio greater than 7 %, as it does for VUV efficiency in Fig. 8. This saturation characteristics with increasing Xe gas mixture ratio has been related to the plasma saturation. Fig. 10 shows the plasma density versus Xe gas mixture ratio under the pressure of 400 Torr. The electron temperature and plasma density have been experimentally measured from the center of sustaining electrode gap by a micro Langmuir probe in coplanar AC plasma display panels(AC-PDPs), in which electrode gap and width are 50 μm and 300 μm, respectively. [11, 12]. It is noted that the plasma density increases and saturates at Ne-Xe (7%) gas mixture ratio. The plasma density of Ne-Xe (7%) gas mixture ratio has a value of 9×10^{11} cm^{-3}, where the electron temperature is about 1.6 eV in this experiment. This saturation characteristics with increasing Xe gas mixture ratio has related to the plasma saturation and self-absorption phenomenon. [8,9,10,13].

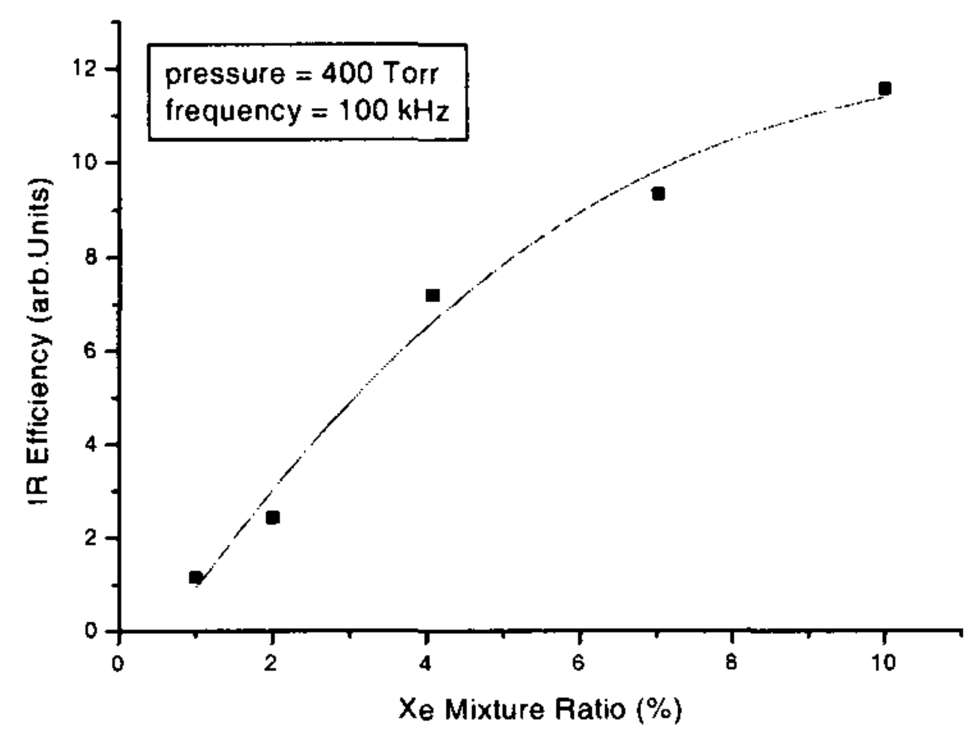

Fig. 9. The IR efficiency versus Xe gas mixture ratio

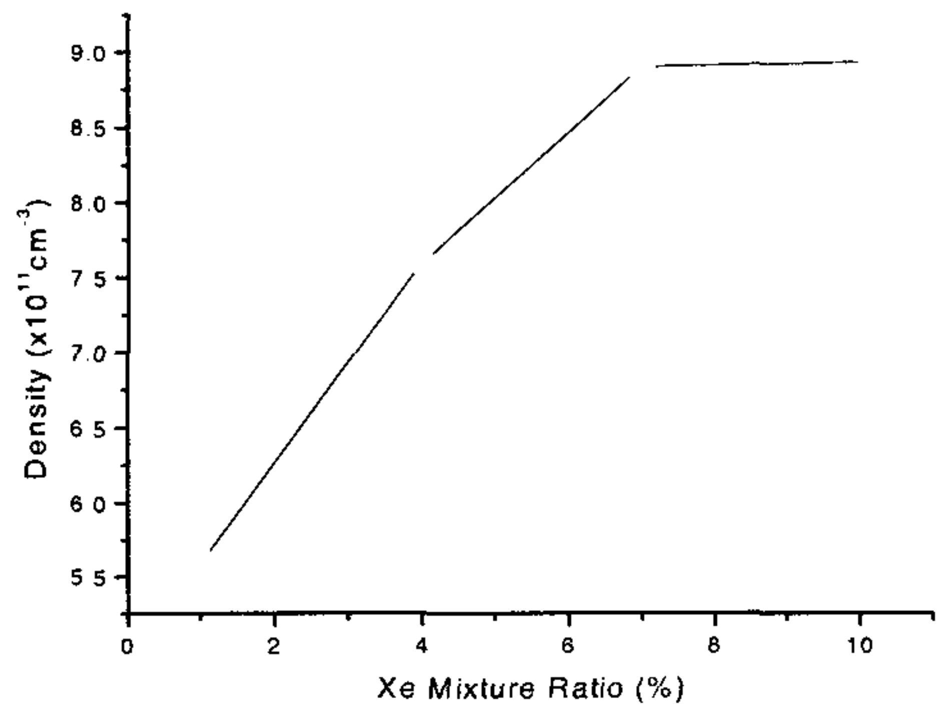

Fig. 10. The plasma density versus Xe gas mixture ratio.

4 Conclusions

We have observed 823 and 828nm infrared light emitted from Xe atoms along with the VUV 147 nm and 173 nm from Xe ($3P_1$) resonance and molecular dimmers Xe_2* in surface discharge AC-PDP. As pressure increases, the probability of collisions between excited Xe* and electron increases, which results in decrease of emission VUV 147 nm. It is noted that for high Xe gas mixture ratio greater than 7 % the increase of the luminous efficiency is found to be saturated. This saturation characteristics with increasing Xe gas mixture ratio has been reported to be related with the plasma saturation. It is found that the Xe atoms emitting IR 823 nm are correlated with $Xe^*(3p_2)$ excited state emitting VUV 173 nm line. It is found that the Xe atoms emitting IR 828 nm are strongly correlated with the $Xe^*(3p_1)$ excited state emitting VUV 147 nm line. The electron temperature and plasma density have been experimentally measured from the center of sustaining electrode gap by a micro Langmuir probe in AC-PDPs. The plasma density from the center of sustaining electrode gap are shown to be maximum value of 9×10^{11} cm^{-3}, where the electron temperature is about 1.6 eV in this experiment.

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