3-dimensional measurement for the light emitted from plasma display panel

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Abstract

We measured 3-dimensional images of the light emitted from plasma display panel by using newly proposed scanned point detecting method (SPDM). From the 3-dimensional emission images, we know that as the sustain voltage increases, intensity of light detected without phosphor increases and the position of the maximum intensity moves to the outside from the electrode gap. Also, we know that 2-dimensional simulations under the assumption that neglects the Y axis variation do not agree with 3-dimensional experiment results.

Introduction

Up to now, many approaches have been tried to improve the luminance and efficiency, power consumption in PDP by proposing the new electrode structure, new gas mixture, and new driving method. Also, 2-dimensional simulation and 2-dimensional emission measurement have been tried to understand discharge physics [1][2]. But in order to understand more precisely discharge physics, 3-dimensional simulation and experiment are required. We measured the 3-dimensional images of light emitted from PDP as a function of the discharge voltage by using the scanned point detecting method.

Background of Theory

Figure 1 shows the principle of scanned point detecting method (SPDM). 2-dimensional measurement system with CCD array can only detect summation of lights that was emitted from each point on 2-dimensional plane. But, SPDM has the point detector with pinhole. The light emitted from the source at the in-focus position can pass through the pinhole and be collected by detector. The light from other sources at the out-of-focus positions is focused in front or behind of the pinhole. That is, it is intercepted by the pinhole [3]. Therefore, by scanning point detector in 3-dimensional direction, the characteristic of 3-dimensional emission in PDP cell can be measured.

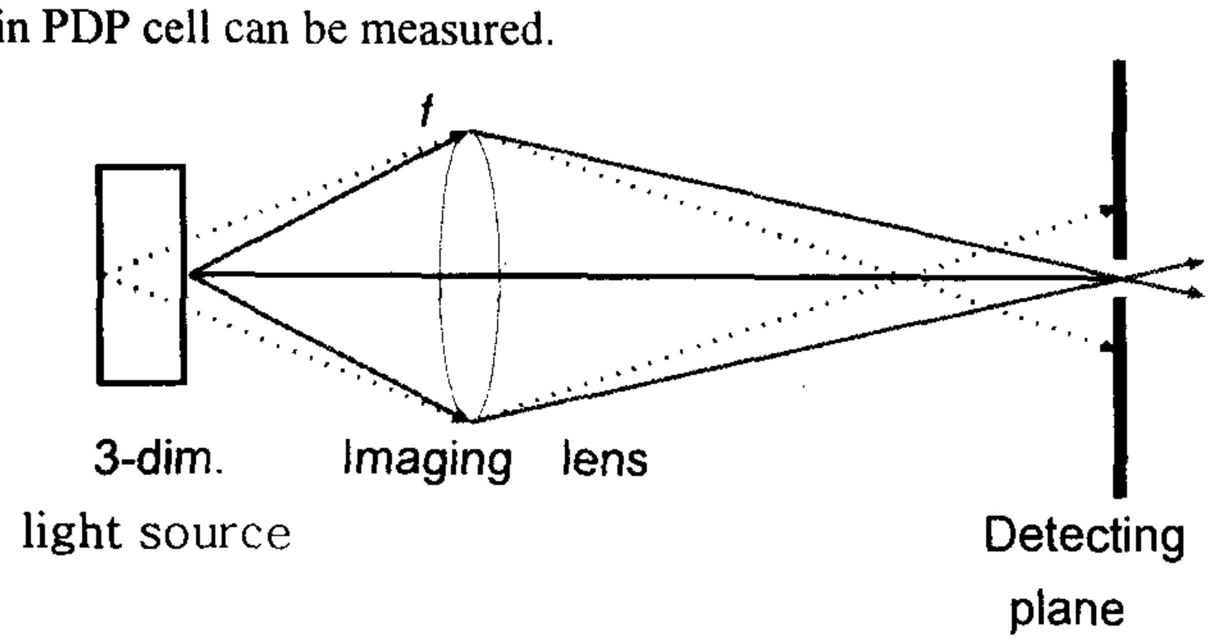


Fig. 1. Principle of scanned point detecting method (SPDM)

Experiments

The panel consists of a front glass plate with ITO electrode, bus electrode, dielectric layer, and MgO layer and a rear glass plate with barrier rib. The ITO electrode was prepared with width 360 µm, gap distance 60 µm and the width of bus electrode was 100 µm, the height of barrier rib was 180 µm. Figure 2 shows the structure of barrier rib and 3-directional scanning direction. Especially, Z-axis of 3-dimensional scanning direction scans to front glass plate from rear glass plate. The firing voltage is 180V and sustain voltage is 149V. Therefore, 3-dimensional experiments are performed in stable voltages of 165V, 180V and unstable voltages of 200V, 220V. 3-dimensional equipment consists of XYZ scanning stage, detector system, pinhole, and object lens. This system collects the light that is emitted from the PDP and passes through the pinhole.

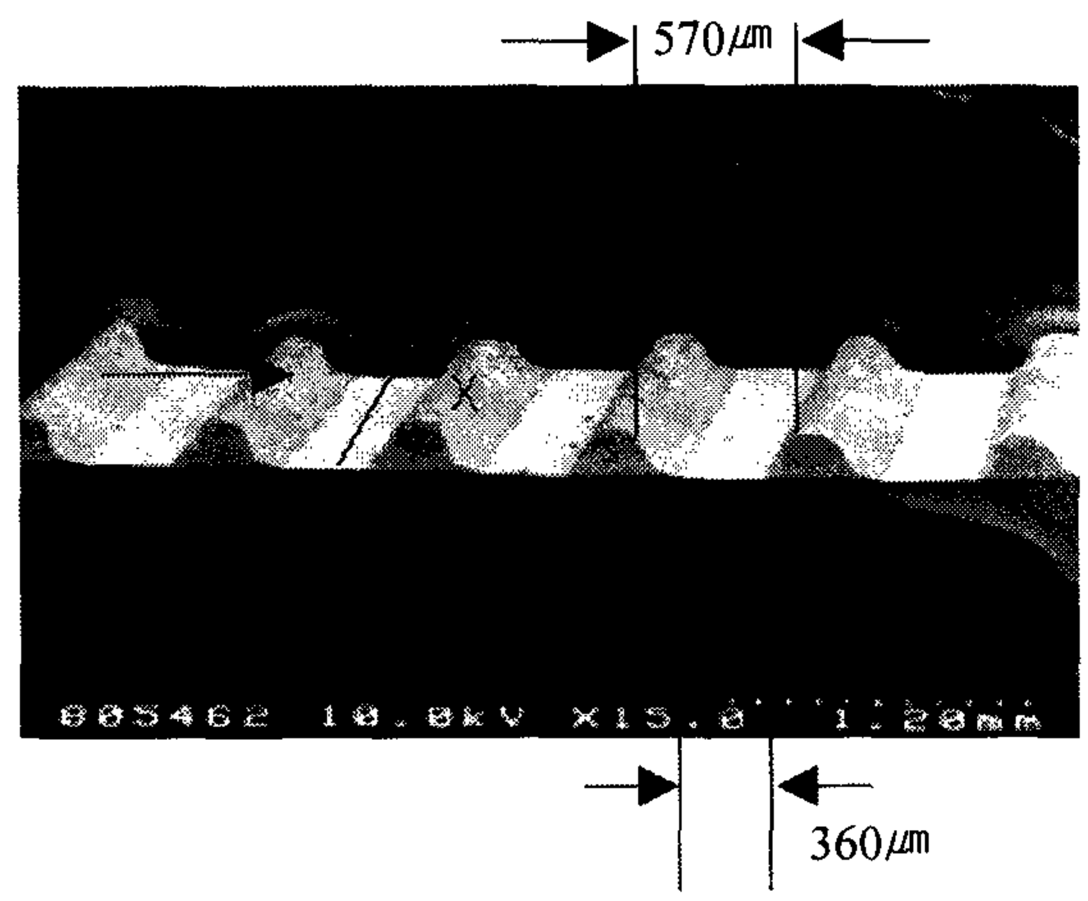


Fig. 2. Structure of barrier rib and 3-dimensional scanning direction

Results and Discussion

Figure 3 shows light intensity distribution on X-Y planes appeared according to the discharge voltage. As discharge voltage increases, the position of the maximum intensity moves to the outside from the electrode gap. Figure 4 shows detected intensity on ITO electrode (X=55,70) and ITO electrode gap (X=63). At first, detected intensity on ITO electrode shows higher value than on electrode gap, but progressing along the Z-axis, detected intensity on ITO electrode gap shows higher value than on the ITO electrode. As discharge voltage increases, detected intensity increases.

Figure 5 shows characteristic images of X-Z planes appeared according to the Y axial range at 165V. Profile of image is equal at various discharge voltages. Image of (a) and (e) is at the near of barrier rib and image of (c) is a center between barrier ribs. 2-dimensional simulations under the assumption that neglects the Y axis variation do not agree with 3-dimensional experiment results. From these results, 3-dimensional simulations are required to get a better understanding of discharge physics of PDP.

Figure 6 shows characteristic images on Y-Z planes appeared according to the voltage. Generally, at Z=100 µm, intensity on the ITO electrode is larger than on the gap of ITO electrode and than detected intensity at Z=200 µm.

Conclusion

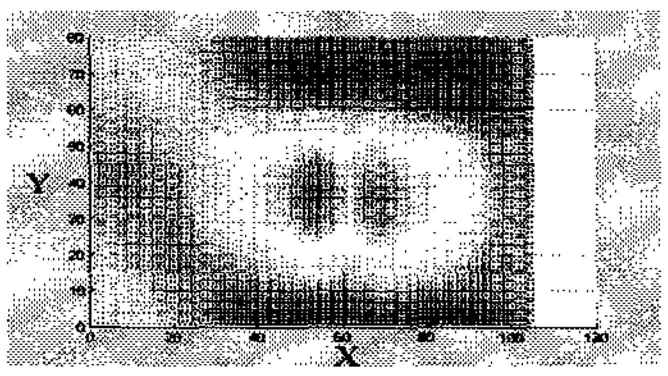
We devised the scanned point detecting method (SPDM) for 3-dimensional measurement of light emitted from plasma display panel and measured 3-dimensional light intensity distribution.

References

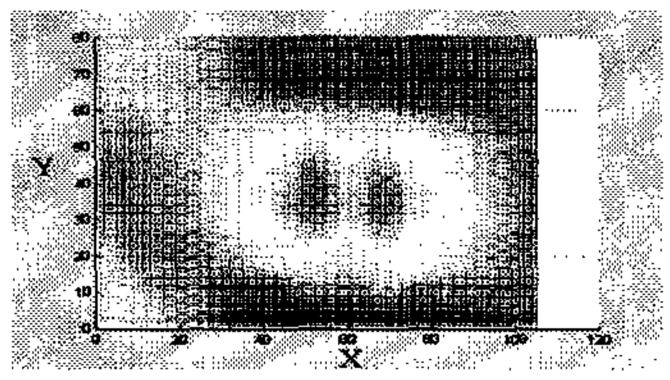
[1] Ki Woong Whang, Heui Seob Jeong, Jeong Hyun, Cha keun Yoon, and Joong Kyun Kim, 98'Asia Display, pp.251-254,1998.

[2] Heiju Uchiike, 98'Asia Display workshop on PDP I, pp. 195-208, 1998.

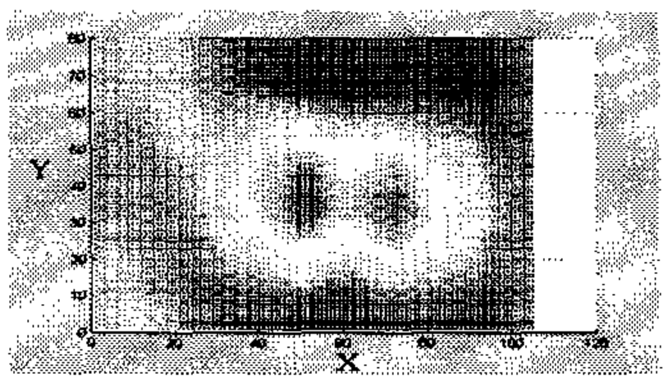
[3] Eugene Hecht, Optics, Addison-Wesley Publishing Company, 1987



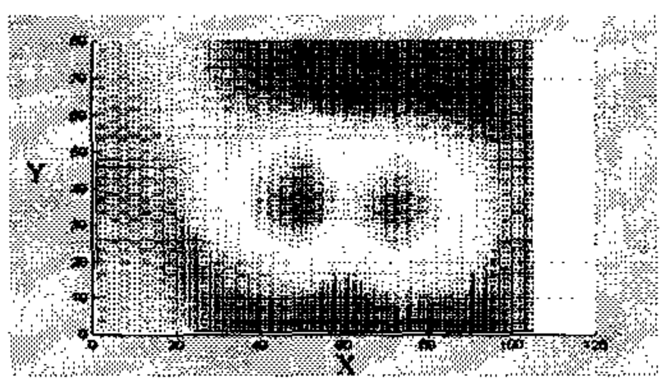
(a) 165V



(b) 180V



(c) 200V



(d) 220V

Fig. 3.Summation images of X-Y plane as a function of the voltage

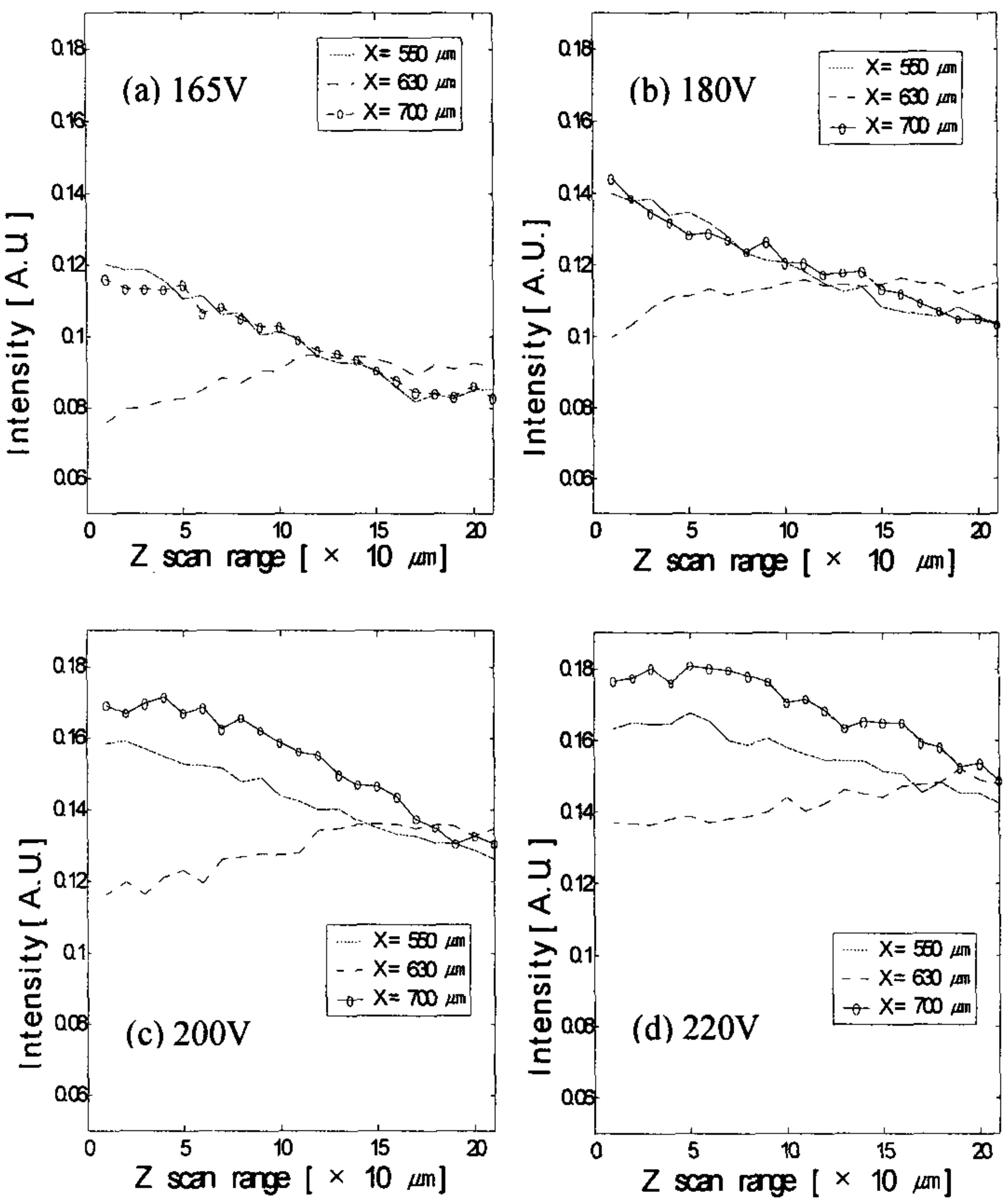
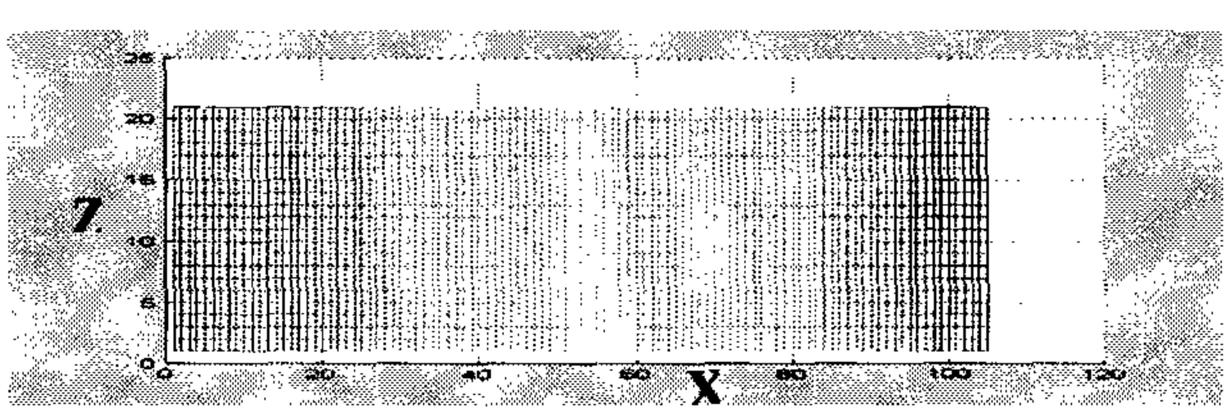
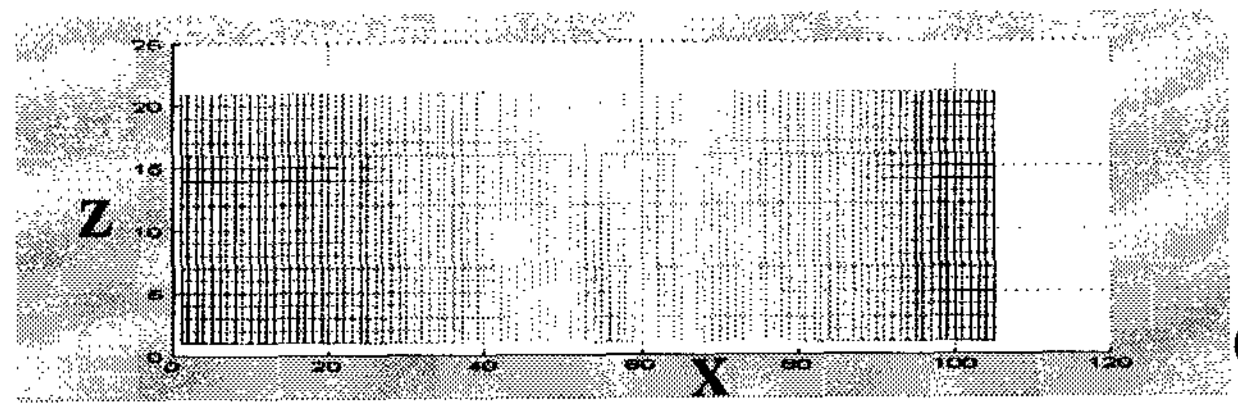


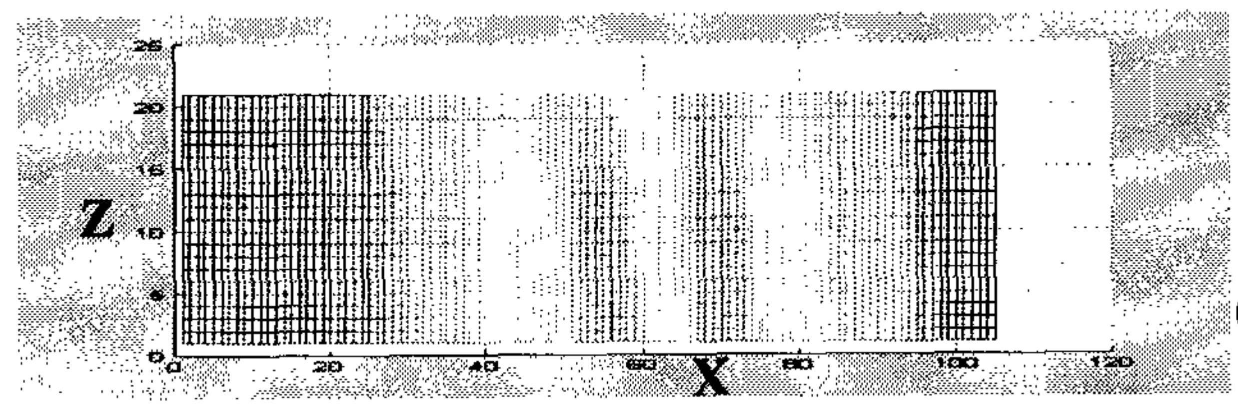
Fig. 4. Intensity of Z-axis at various discharge voltages (Y=370 μm)



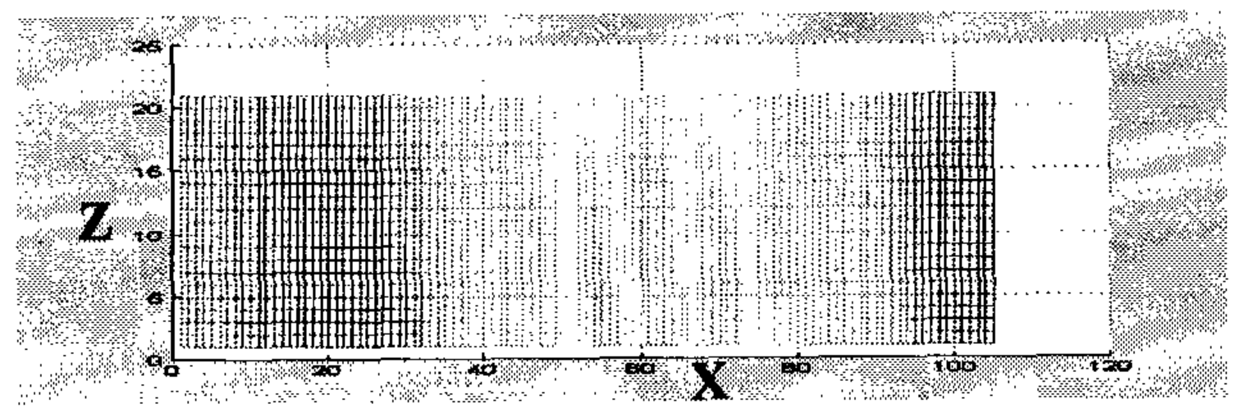
(a)



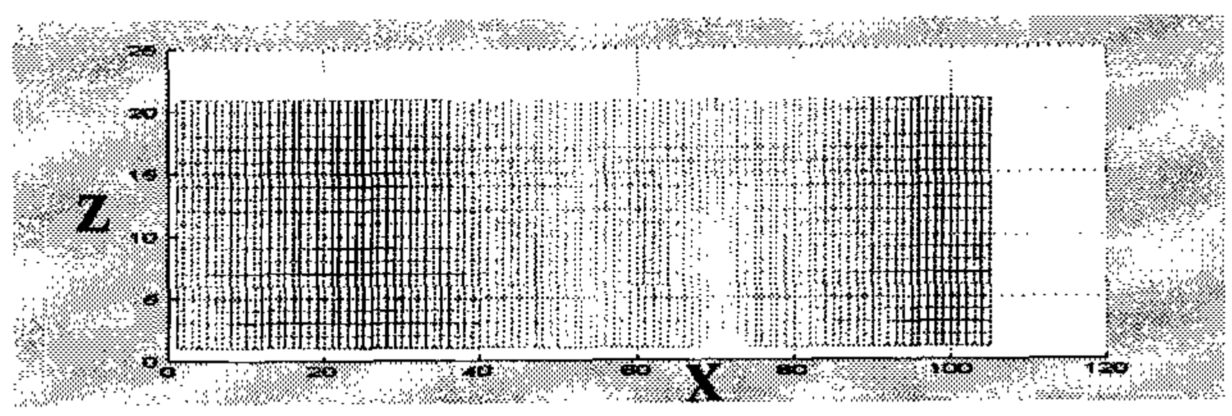
(b)



(c)



(d)



(e)

Fig. 5. Images of Y axial scan

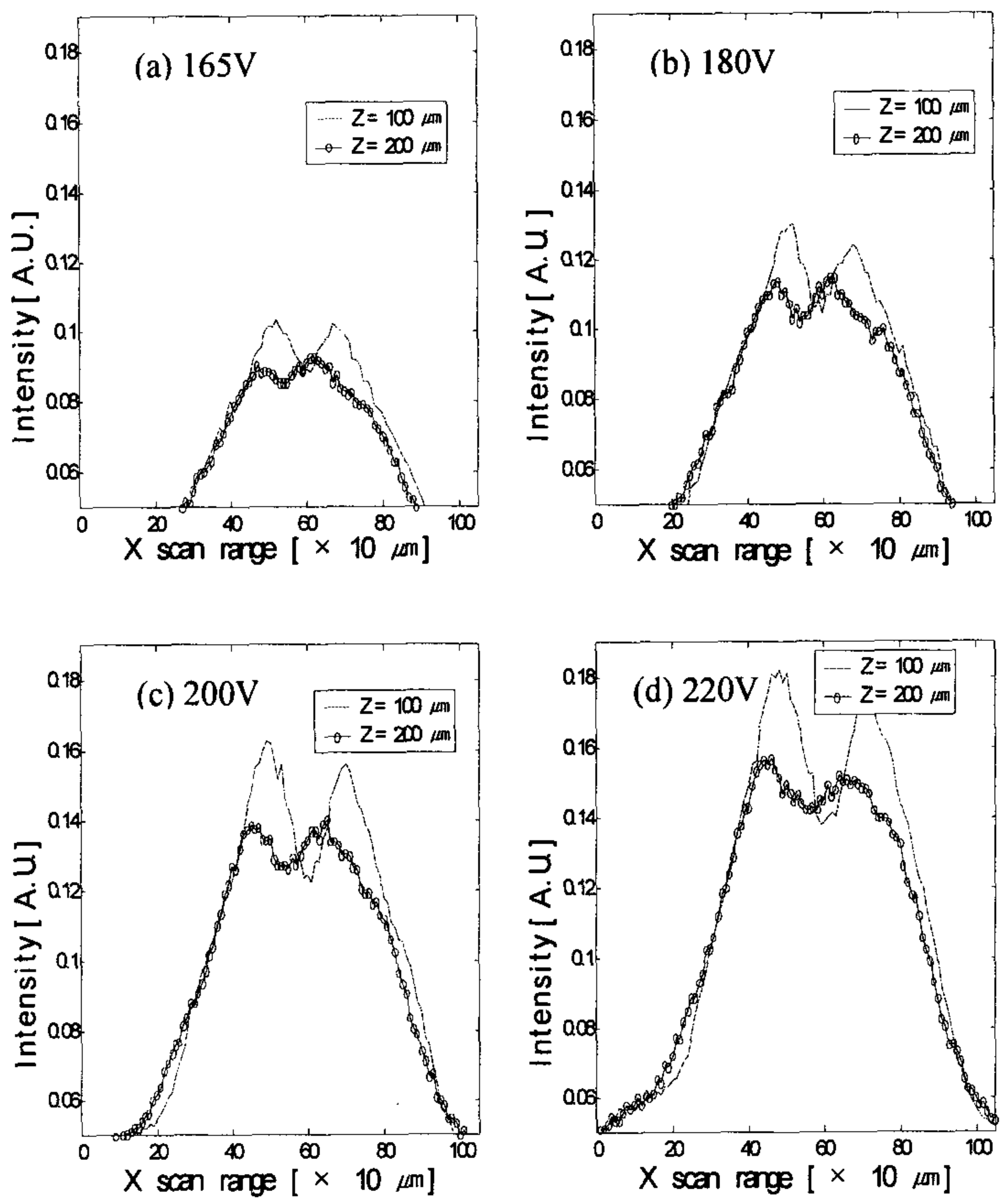


Fig. 6. Intensity of X-axis at various discharge voltages