Role of Redeposition of Sputtered Mg Particles in Image Sticking

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Abstract

One of important factors responsible for image sticking in AC PDP is a sputtering of MgO layer under ionic bombardment. Sputtered Mg particles can migrate to the neighbor cells, where the migration makes a change of discharge condition. It leads to the local non-uniformity of a luminescence in the panel, resulting in the image sticking.

1. Introduction

One of serious problems of image quality in plasma panels is the image sticking. Usually, image sticking is divided into temporary and permanent. Temporary image sticking (it is also can be divided into the bright, dark, and boundary image sticking), disappears in time. It differs from the permanent image sticking which arises due to the degradation of the material in panels and isn't recoverable.

The study on the image sticking is found in various research works [1-3], but its mechanism isn't still well understood. Image sticking is a complex phenomenon related to the various elements. All factors connected with luminescence and discharge take part in this phenomenon.

2. Experimental

It is well known that the life time of panels is determined by erosion of MgO layer due to the ion bombardment [4, 5]. The sputtered Mg particles can deposit both on the MgO film surface and the phosphor layer. In addition, they can migrate to the periphery cells due to the gas flow which is caused by the pressure difference between "turned on" and "turned off" cells [3]. This work is focused on the role of redepostion of sputtered Mg particles in the image sticking.

3. Results and discussion

Memory effect

It has been found that both dark and bright image sticking have memory effect. This effect means that the influence of temporary image sticking can't fully disappear under turned off condition. When a panel is turned on, it remembers the previous image even after a very long time.

We produced a dark image sticking pattern in a way that a box shape image has been turned on at the center region for a long time. Then the power is turned off for 3 times at certain intervals. The temporal variation of red intensity at dark image sticking region is given in Fig. 1, which is measured using the spectroscopy. It is seen that the red intensity decreases gradually with the turn on time. When the panel is switched to turn on states, the brightness returns not to the original value ($t = 0$) but to the previous values. Same behaviors have been observed for green and blue colors.

This memory effect is also found for bright image sticking, as seen in Fig. 2. The brightness difference between the patterned and non-patterned areas is conserved after the panel is switched to turn on state. It is supposed that the memory effect is caused by the migration of Mg particles sputtered from MgO surface, which will be discussed later.

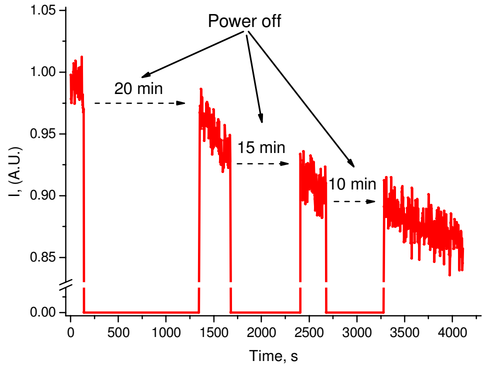

Fig. 1. Temporal variation of red intensity in dark image sticking, measured by spectroscopy.

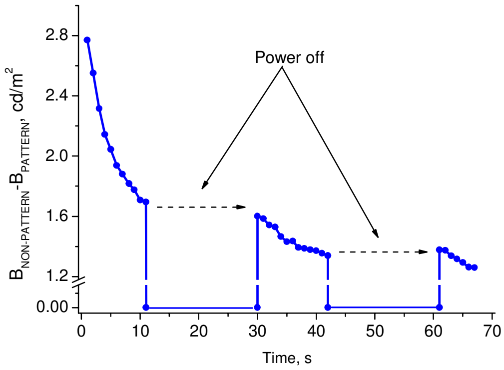

Fig. 2. Brightness difference between non-pattern and pattern areas.

Change of luminescence at the boundary

Figure 3 shows a scheme of experiment for investigating the change of luminescence at the boundary between patterned and non-patterned regions. Red, green and blue box patterns are turned on for three minutes and then switched to the full red pattern. The temporal behaviors of brightness difference between pattern and non-pattern areas are presented in Fig.4. The brightness difference is larger when switching from blue and green boxes to full red pattern than when switching from red box to full red. It is also ascertained with the naked eye, as shown in Fig. 3. A complimentary color to the previous one is observed as a form of dark image sticking. This phenomenon is likely to be caused by the Mg migration from discharge cells to non-discharge region. The sputtered Mg particles move to the non-discharge areas due to the pressure difference caused by the higher pressure in the discharge region. As a result, the firing voltage is reduced and the brightness thus increases at the boundary region.

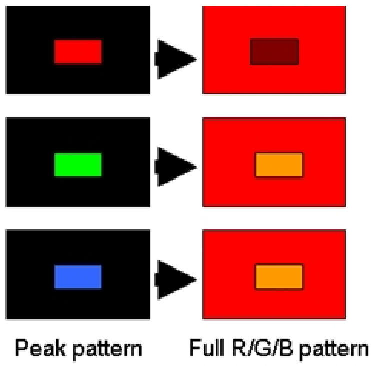

Fig. 3. Scheme of experiment for bright image sticking.

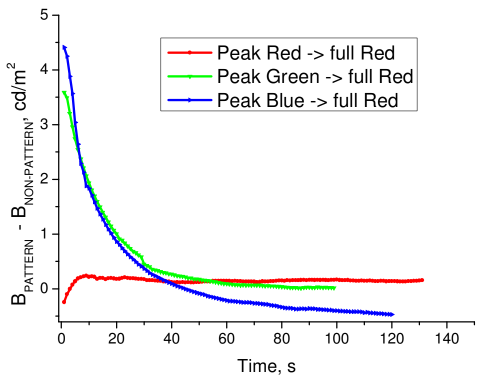

Fig. 4. Brightness difference between pattern and non-pattern areas after R, G, and B box patterns is switched to full red pattern.

Brightness profile at the edge of discharge area

If the migration of Mg particles gives a little influence on the discharge, the brightness at the edge of turn on area will have a smooth and continuous profile. Brightness distribution measured at the pattern and non-pattern areas is presented in Fig 5, which shows that the brightness at the boundary is sharply increased. This means that the MgO degradation in the patterned area isn't ignorable. If the particle transportation to the edge region is avoided, the variation of light intensity can be smaller and the boundary width can be considerably reduced.

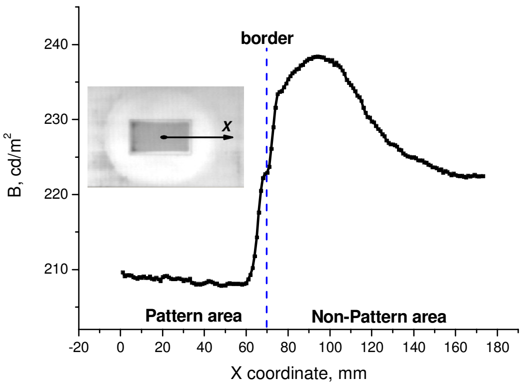

Fig. 5. Distribution of brightness in the horizontal direction.

Dependence of image sticking on previous pattern

When MgO is sputtered, a part of Mg particles deposits on the phosphor surface, where it is kept by adhesive force of phosphor. This force is much less than the cohesion force between molecules in MgO film. For this reason, Mg particles on the phosphor layer escapes more easily to the discharge space. As a result, the concentration of Mg particles is high in the cells where previously turned on. Consequently, the region where already turned on enough time has stronger image sticking. Figure 6 shows the brightness distribution in full white mode after displaying cross hatch pattern. It is noticed that the image sticking is more evident in the areas where the cross hatch pattern was preserved.

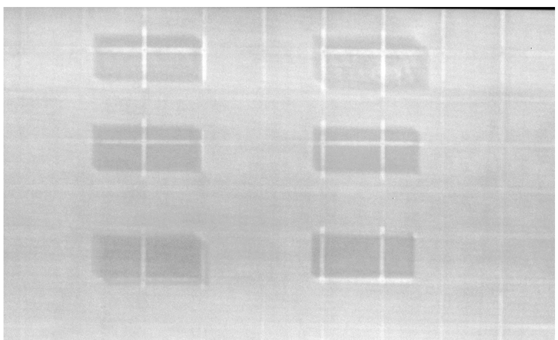

Fig. 6. Brightness distribution in full white mode after the panel turns on for a while under cross hatch pattern.

Different stoichiometric of MgO surface layer between pattern and non-pattern areas

MgO molecule is unstable in gas phase and dissociates immediately into Mg^{2+} and O^{2-}. This phenomenon leads to the change of the stoichiometric of MgO surface. Figure 7 shows the Mg/O ratio for different regions. The maximum and minimum Mg/O ratios are found at the boundary and discharge regions, respectively. This is a good verification that Mg particles are migrated from discharge area to non-discharge one.

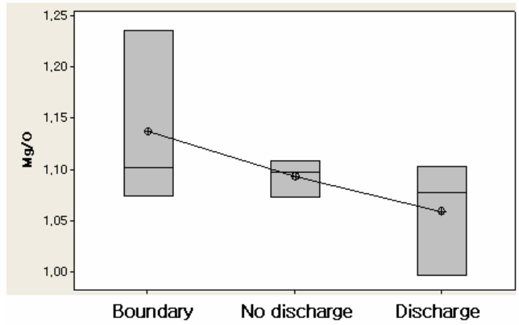

Fig. 7. XPS-analysis of MgO in different areas of panel.

4. Summary

The sputtering of MgO, followed by the redeposition of Mg particles plays an important role in the image sticking. The migration of sputtered Mg particles leads to the change of discharge condition at the periphery, which is a major cause of boundary image sticking. That is proved by the memory effect and the increasing brightness at the edge region of box pattern in conjunction with the XPS analysis. If Mg migration is avoidable, the boundary image sticking can be remarkably reduced.

5. References

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