Journal of the Korean Ceramic Society
Vol. 39, No. 12, pp. 1124~1127, 2002.

Electron Reflecting Layer with the WO_3-ZnS:Cu.Al-PbO-SiO_2 System Concerned in Doming Property of Shadow Mask in CRT

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(Received October 19, 2002; Accepted October 30, 2002)

ABSTRACT

In this paper, we studied the effects of the electron reflection on shadow mask on which the electron reflecting materials with WO_3-ZnS-PbO-SiO_2 system were screen-printed and we evaluated the variation of the electron beam mislanding in CRT. As a result, the green emitted spectra on the electron reflecting layer are observed due to the transformation of the electron energy, when the electron impacted on shadow mask. The beam mislanding is reduced about 40% in comperision with that of CRT made by the conventional method.

Key words : Shadow mask, CRT, Beam mislanding, Electron reflecting layer, Screen-printing

1. Introduction

The shadow mask CRT to have an excellent color quality, response time, brightness and viewing angle is mainly applied to television set and computer monitor for many years. Improvement of the color quality and the construction such as styling and fashion has led to the fully developed product I think. [1-3]

Alongside of system improvement such as digital technology and HDTV, the massive growth in computer application and the rapid development in multi-media era in particular are going to help ensuring that the shadow mask CRT remains the main mass produced by means of display for a long time to come.

Almost everything in and around the color CRT can have an effect on color purity. The main factors that have an effect on color purity are the black matrix and phosphor coating, shadow mask, electron gun, deflection coil and manufacturing process. Shadow mask heats up to around 80°C in operation. This rise in temperature causes the shadow mask to expand and bulge. This bulging is called doming. Doming leads to displacement of the mask holes and therefore to landing changes called mislanding, these results give rise to the degradation of the color purity in CRT.

Heavy metal oxides like WO_3, Bi_2O_3, PbO have been generally used to reduce the doming of the shadow mask. It was reported that some methods such as spray coating, thermal evaporation, screen printing is used to form the electron reflecting layer on the shadow mask with these heavy metal oxides materials and among them screen-printing method was the best effective.[4-9] In this study we had tried to apply the electron reflectiving material with the WO_3-ZnS:Cu.Al-PbO-SiO_2 system as new material to shadow mask to overcome the former patents of other companies about the mislanding and to reduce the mislanding of the electron beam in CRT.

2. Experiment

2.1. Preparation of Paste for Screen Printing

The ZnS:Cu.Al and WO_3 powders as shown in Fig. 1 sieved with 250 mesh were mechanically mixed by using ball mill. These powders, nitrocellulose as organic binder, glass frit with PbO-SiO_2 system as inorganic binder and buthylcarbitol as solvent were used to make paste for screen-printing. These materials were placed in a round container and were mixed for 1 h. The mixture was kneaded by 3 roll mill for 3 hs and was made to paste.

2.2. Screen Printing on the Shadow Mask

Paste layer with the WO_3-ZnS:Cu.Al-PbO-SiO_2 system of the composition shown in Fig.2 was coated on the shadow mask by screen-printing method and was dried at 80°C for 10 min. The shadow mask with electron reflecting layer was formed and was blackened. Then we prepared CRT with this shadow mask.

2.3. Characterization

Scanning Electron Microscopy(SEM) was used to identify microstructure of the screen-printed layer on shadow mask. The back scattered coefficients have been measured by auger electron spectroscopy at accelerating voltages of 3 kV, 7 kV, 10 kV, 20 kV and 30 kV. Primary beam current is 1 nA and the grid of secondary electron detector is 150 V, the

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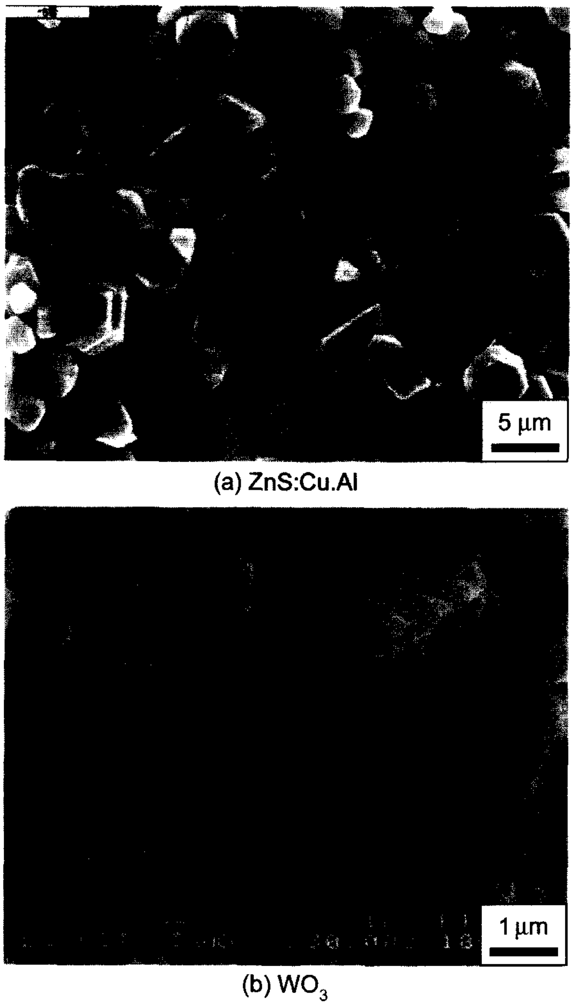

Fig. 1. SEM micrographs of powders for preparing the paste for screen-printing.

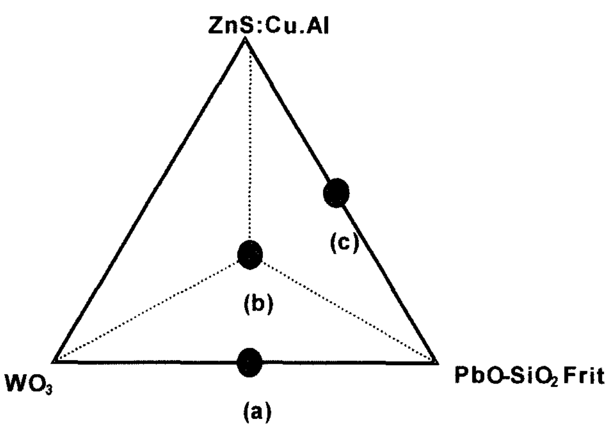

Fig. 2. The composions of the pastes for screen-printing.
(a) 50% WO_3 - 0%ZnS:Cu.Al - 50% PbO-SiO_2.
(b) 33% WO_3 - 34%ZnS:Cu.Al - 33% PbO-SiO_2.
(c) 0% WO_3 - 60%ZnS:Cu.Al - 40% PbO-SiO_2.

tilted angle of sample is 0° in measuring back scattered coefficients. The mislanding of electron beam for doming property in CRT was measured by using universal tester &

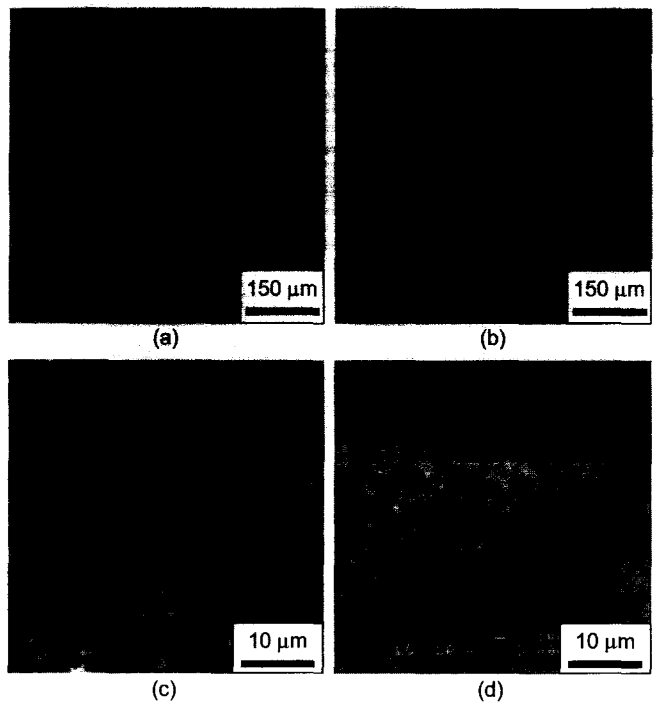

Fig. 3. The shapes of the screen-printed shadow mask and the microstructures of the screen-printed layer.
(a) as the blackened AK shadow mask.
(b) as the screen-printed AK shadow mask.
(c) the surface of the screen-printed layer.
(d) the crossed section of the screen-printed layer.

microscope. Cathodoluminescence of the printed shadow mask and the degration of the color purity owing to the mislanding are measured by Minolta CS-1000.

3. Result and Discussions

Fig. 3 shows the shapes of the screen-printed shadow mask and the microstructures of the screen-printed layer with the WO_3-ZnS:Cu.Al-PbO-SiO_2 system on shadow mask. The screen-printed layer is apparently in good shape from Fig. 3(b) and microscopically has about 20 µm of thickness and has many sponge-like pores and the aggregated particles like phosphor, tungsten oxide from Fig. 3(c),(d).

Fig. 4. shows the spectra of the cathodoluminescence on the screen-printed layer. The shoulders of the CL spectra owing to the emission of ZnS:Cu.Al are observed at 535 nm. The hight of the houlder become lower when WO_3 is added. These CL spectra mean that some of the energy of the electron which come out of the electron gun does not convert to the heat energy which cause the mislanding of the electron beam on the screens but converts to the light energy when the electron is hitted on the screen-printed layer with WO_3-ZnS:Cu.Al-PbO-SiO_2 system.

Fig. 5 shows the back scattered coefficients of the screen-printed layer on the shadow mask. The back scattering of the electron is caused by the electron reflecting on the screen-printed layer with the WO_3-ZnS:Cu.Al-PbO-SiO_2 sys-

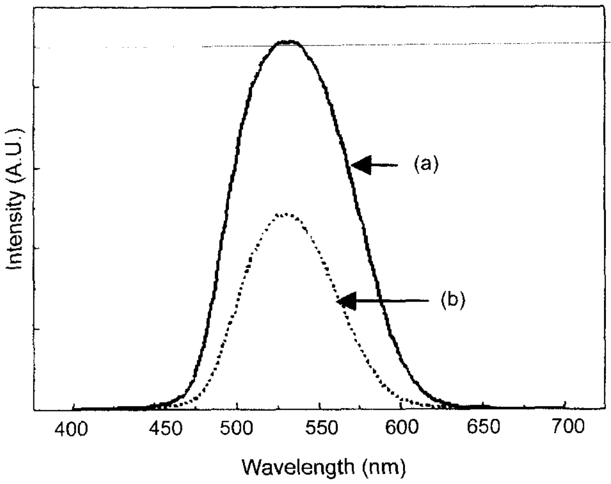

Fig. 4. The spectra of cathodoluminescence in the screen-printed shadow mask.
(a) 0% WO_3 - 60%ZnS:Cu.Al - 40% PbO-SiO_2.
(b) 33%WO_3 - 34%ZnS:Cu.Al - 33% PbO-SiO_2.

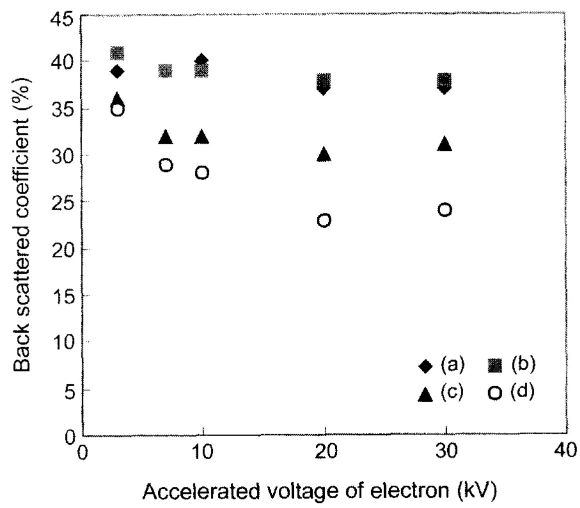

Fig. 5. The back scattered coefficients of the screen-printed layers on the shadow mask.
(a) 50% WO_3 - 0%ZnS:Cu.Al - 50% PbO-SiO_2.
(b) 33% WO_3 - 34%ZnS:Cu.Al - 33% PbO- SiO_2.
(c) 0% WO_3 - 60%ZnS:Cu.Al - 40% PbO-SiO_2.
(d) as the blackened AK shadow mask.

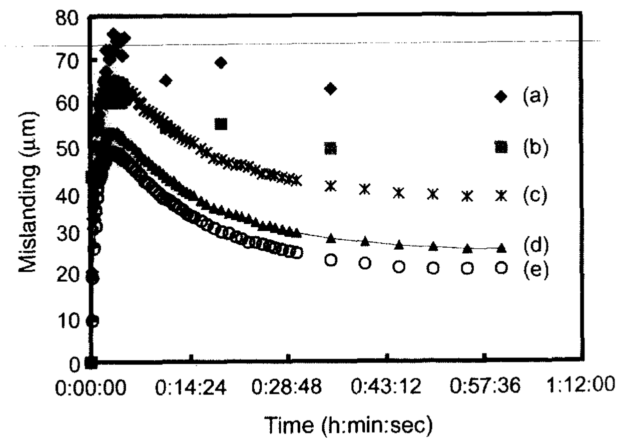

Fig. 6. Variation of the electron beam mislandings in CRT with the printed shadow mask.
(a) as not printed (b) WO_3 sprayed.
(c) 0%WO_3 - 60%ZnS:Cu.Al - 40%PbO-SiO_2.
(d) 33%WO_3 - 34%ZnS:Cu.Al - 33%PbO-SiO_2.
(e) 50%WO_3 - 0%ZnS:Cu.Al - 50% PbO-SiO_2.

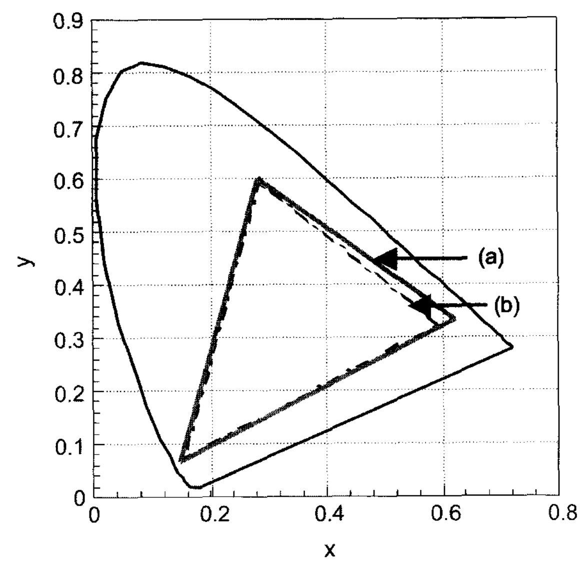

Fig. 7. The change of the color coordinate in CRT by the mislanding. (a) 50 μm mislanding (b) 75 μm mislanding.

tem. The back scattered coefficients of the screen-printed layer show 35~40% and are higher than that of the blackened AK shadow mask which shows about 25%. The back scattered coefficients of the Fig. 5(a),(b) show about 40% and are highest of the compositions with the WO_3-ZnS:Cu.Al-PbO-SiO_2 system.

Fig. 6 shows the mislanding of the electron beam to the screen in CRT. In case of the samples of which the shadow masks are screen-printed with the WO_3-ZnS:Cu.Al-PbO-SiO_2 system, the maximum mislanding is reduced about 40% in comparison with the samples which has the only blackened shadow mask or the one used by the conventional spraying method, besides, when the mislanding is stabilized after 1 h passed, the mislanding is lower as shown from Fig. 6. In case of Fig. 6(c), this sample shows the brightest emission but the lowest back scattered coefficient and the largest mislanding among the printed samples with the WO_3-ZnS:Cu.Al-PbO-SiO_2 system from Figs. 4~6. With the addition of tungsten oxide in WO_3-ZnS:Cu.Al-PbO-SiO_2 system, back scattered coefficients are increased and mislanding are improved. These results, we think, are owing to the conversion of energy from heat to light emission and the back scattering of the electron.

Fig. 7 shows the change of the color coordinate by the mislanding. Color purity at the 50 μm mislanding is purer than that at the 75 μm mislanding and the change of the red color coordinate occur extreamly in comparison with other color as shown in Fig. 7. From the result, We can clearly know that the mislanding is reduced, color purity is improved in case of using the the screen-printed shadow mask with WO_3-ZnS:Cu.Al-PbO-SiO_2 system.

4. Conclusion

We got to the following conclusions as results of the evaluation for the electron reflecting layer screen-printed with the WO_3-ZnS-PbO-SiO_2 system on shadow mask in CRT.

1. The electron reflecting layer is composed of the compositions like W, Zn, S, Pb, SiO_2, the good shaped layer without clogging of shadow mask hole is observed.

2. The green emitted spectra on the electron reflecting layering is observed due to the transformation of the electron energy, when the electron impacted on shadow mask.

3. The mislanding of the electron beam due to the electron reflecting layer with the WO_3-ZnS-PbO-SiO_2 system is improved because of the energy conversion and the back scattering of the electron on the screen-printed surface of the shadow mask.

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