Characteristics of $12CaO{\cdot}7Al_2O_3$ Electride as Electron Emission Layer for PDP

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Abstract

In order to enhance discharge efficiency of Plasma Display Panel (PDP), we used an electride as electron emission layer for PDP during PDP discharge process. As the electride used in this study, $12CaO7Al_2O_3$, has low work function, it is expected to yield high electron emission during glow discharge process. $12CaO7Al_2O_3$ powder was synthesized from $CaCO_3$ and $Al(OH)_3$ powder and Ca treated for realization of electride characteristics. The $12CaO7Al_2O_3$ powder was coated on the surface of dielectric layer of PDP and discharge characteristics of electride material were evaluated.

1. Objectives and background

Plasma display panel (PDP) is growing rapidly in size and in use for TV applications. PDP is, in essential, an array of micro-fluorescent lamps located in each discharge cells. As the volume of discharge is few hundreds micrometers, the discharge is dominated mostly by cathode glow region and its efficiency is relatively low. This low discharge efficiency is originated mainly due to the fact that ~70% of electric energy into the discharge is wasted in heating ions in the cathode glow region. In order to reduce this loss, it is essential to increase the yield of secondary electron emission from electron emission layer, MgO on dielectric protect layer. In this research, we used $12CaO7al_2O_3$ electride as the electron emission layer. $12CaO7Al_2O_3$ is an electride which is stable up to 300℃ and has very low work function, ~0.6eV. This low work function should facilitates electron emissions via various mechanisms such as photo-, Auger- and field emissions. We coated this electride material on the surface of dielectric layer and evaluated luminance and its efficiency.

2. Results

2.1. Synthesis of $12CaO7Al_2O_3$

$12CaO7Al_2O_3$ powder was synthesized via simple solid state reaction process. $CaCO_3$ and $Al(OH)_3$ powders were mixed according to molar ratio. The mixed powder was heated to 1350 °C and kept for 6 hours at the temperature under pure oxygen atmosphere. After the reaction, the powders were Ca-treated by sealing the powder in a quartz tube with Ca. The sealed sample was heated to 700°C and kept at the temperature for 6 hours.

Figure 1 shows XRD pattern of the powders after the Ca-treatement. The major peaks of the sample were noted to originate mainly from the electride phase.

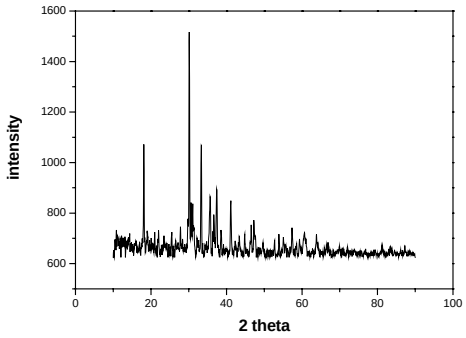

Figure. 1 XRD pattern of Ca-treated $12CaO7Al_2O_3$

2.2. Characteristics of $12CaO{\cdot}7Al_2O_3$ Electride as electron emission layer of PDP

As the electride is in powder form, the transparent dielectric layer was coated with the powder. For the coating process, the dielectric layer was pre-sintered at 450 °C and electride powder suspension was coated on the surface. After drying, the sample was fully sintered. After the front panel is coated with MgO, rear plated coated with phosphors were sealed with the front plate for panel preparation.

Figure 2 shows the luminance of the panel with electride coating along with reference panel.

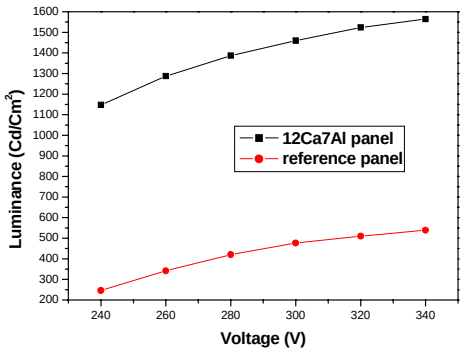

Figure 2. Luminance of the panel with $12CaO7Al_2O_3$ electride along with reference panel.

The luminance of the panel with the electride coating was increased significantly. The increased electron emission from the layer should have increased the luminance of the panel. The luminance efficiency calculated with the panel was about 2 times higher than that of the reference panel (Figure 3).

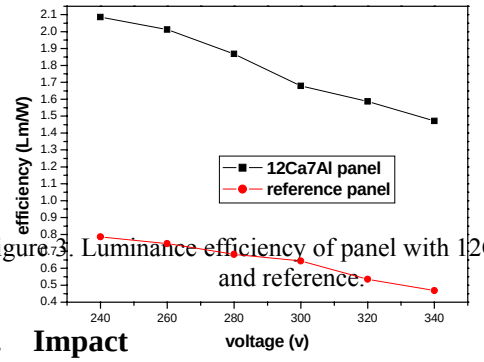

Figure 3. Luminance efficiency of panel with $12CaO7Al_2O_3$ and reference.

3. Impact

With the use of electride powder at the surface of dielectric layer as electron emission layer, luminance and luminance efficiency of PDP was enhanced about 200-300%. The low work function value of the material is believed to have promoted the electron emission, eventually improving luminance and luminance efficacy. This work demonstrated a possibility of using new class of material as electron emission layer for PDP.

4. Acknowledgement

5. Reference

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