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NEW BOTTOM EMISSION OLED STRUCTURE TO ENHANCE OUT-COUPLING EFFICIENCY

HP INC

New bottom emission OLED structure to enhance out-coupling efficiency

Abstract

This invention discloses a new structure of bottom emission type OLED display which enhances the light out-coupling efficiency. A reflective material is deposited on the side wall of bank layer of an OLED device. Together with the semi-transparent anode, and reflective cathode, the structure would collect the light to left/right/top all re-direct to bottom side. And thus greatly improve light out-coupling efficiency.

Background

Figure 1 is an example of conventional OLED display cross section. Driving TFT on the substrate will supply current to the anode electrode. Then the current flows through the contacted OLED area and sink at the cathode. This is a bottom emission OLED device. The cathode is high reflective metal, and the anode is a semi-transparent metal. Planarization and bank layers are insulative materials.

When the OLED device emit light, it actually goes every direction. (1) For the light in a vertical direction, the light will emit externally through anode at the bottom side. The light that proceeds in a top direction will bounce back by cathode. (2) However, for light in a horizontal direction, the light will be trapped by the structure and result in efficiency loss.

It is the purpose of this invention to collect the light in all directions as much as possible and guide the light to emit towards the direction of the user.

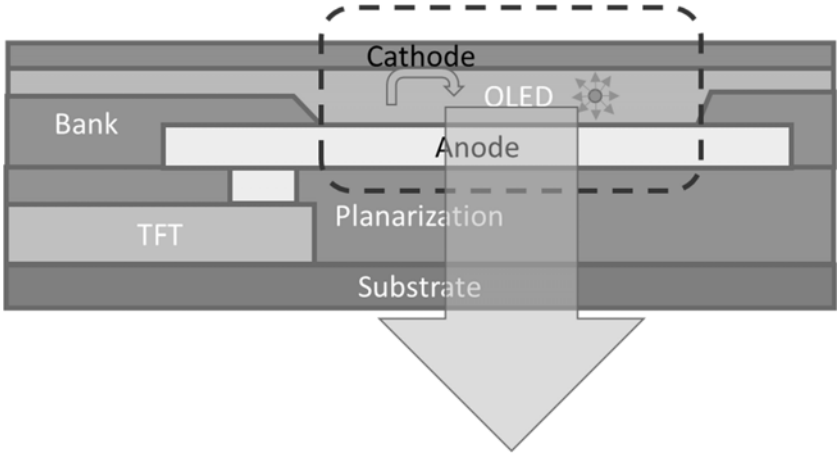

Figure 1. Cross session of conventional bottom emission OLED structure.

Invention Description

After bank layer process, another layer of high reflective metal is added on the side wall (taper area) of bank layer. As a result, the light of OLED that goes in a horizontal direction would be re-directed at the taper area of bank layer because of the newly added high reflective metal. The light will firstly re-direct to top side, and then re-direct for a second time by cathode back to bottom side. Therefore, the out-coupling efficiency for bottom emission would be considerably increased. The

light originally headed towards a horizontal direction is redirected to bottom direction by reflection (twice).

A second bank layer may be added after the high reflective metal on taper area of first bank layer. This is to passivate the taper area of first bank layer and to avoid device electrically short or leakage issues. Meanwhile it still remains good out-coupling efficiency as first design.

For both proposals, the taper angle of 45 degree would be considered as optimal. Too large to too small of an angle would be not effective for light collection. Note the newly added reflective material only lies on the side wall of the bank layer. It may also cover a little bit on top of bank layer, and anode layer, but won't cover most of the area of anode.

As for the materials selection, (1) the anode is semi-transparent materials, examples including ITO, IZO, IGZO, etc, (2) the cathode is reflective & conductive materials, examples including Al, Ag, etc, and (3) the newly added material on side wall of bank, is also reflective materials (but not necessarily conductive material). Examples including Al, Ag, etc.

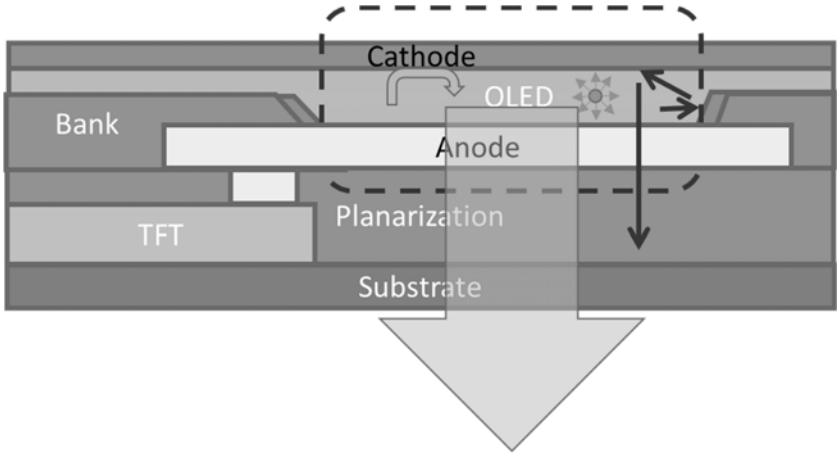

Figure 2. Cross session of proposed bottom emission OLED structure.

Advantages

- New OLED device/display structure that largely improve light out-coupling efficiency, for bottom emission OLED.
- Full usage of most of the light generated to all directions.
- The light originally in the horizontal direction is redirected (twice) towards the bottom direction by reflection.
- The newly added process is on the TFT backplane side. No impact on OLED evaporation process or equipment. Any existing facility can do this.
- Higher brightness is achievable because of better light out-coupling efficiency. Or, lower power consumption at the same brightness level.

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