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Deposition of Black Material on Metal Traces Surrounding Display Screen Blind-Holes to Increase Camera Performance and Improve Aesthetic Appearance

Sangmoo Choi

Deposition of Black Material on Metal Traces Surrounding Display Screen Blind-Holes to Increase Camera Performance and Improve Aesthetic Appearance

Abstract:

This publication describes techniques and apparatuses for increasing camera performance and improving the aesthetic appearance of electronic device display screens with front facing cameras that utilize display screen blind-holes. The techniques include depositing a black material on metal signal traces (metal traces) located in an inactive area of the display screen. The black material is positioned to increase the viewable area of the front-facing camera, reduce the size of the inactive area (e.g., a display screen blind spot), hide reflective metal traces present on a layer of the display panel, and reduce the occurrence of the lightguide effect on image quality.

Keywords:

Front-facing camera (FCAM), under-display camera, image sensor, optical transmissivity, encapsulation glass, black material, black masking material, mask, low-reflection material, low-reflection layer, display blind spot, metal trace, signal trace, touch sensor, touchscreen, pixel, active, inactive, blind-hole

Background:

The increasing use of electronic devices for gaming, productivity, entertainment, and video communication has resulted in consumer demand for devices with larger screen sizes. To provide a larger screen size without enlarging the electronic device itself, a manufacturer may increase the screen-to-body ratio of the device. Increasing the screen-to-body ratio requires expanding the active area of a display panel module (e.g., display screen) of the electronic device closer to the outer edge of the electronic device, resulting in a smaller bezel area.

As a result of the limited bezel space available, in some electronic devices one or more front-facing cameras (FCAM), including an image sensor, are positioned under the display screen of the electronic device, as illustrated in Figure 1. In such a configuration, the "under-display" camera 104 captures images through the display screen 102 of the electronic device 100.

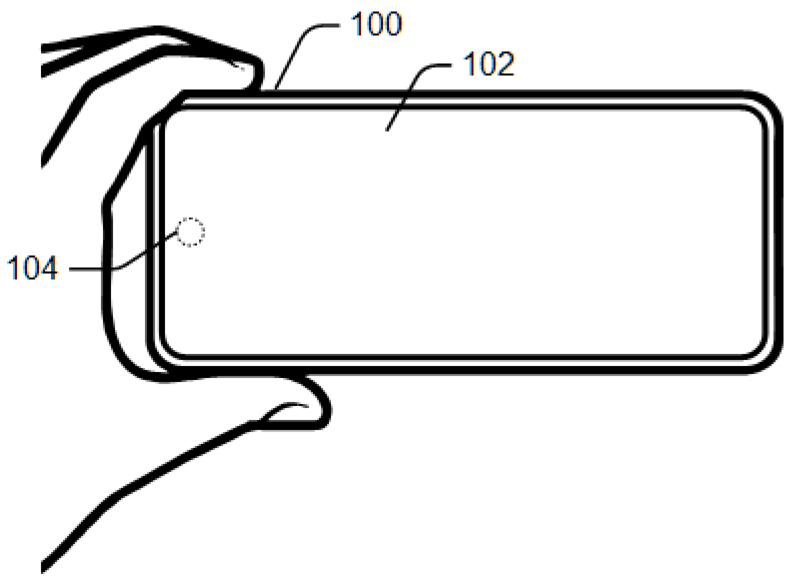

Figure 1

One option for an under-display FCAM is to have a transparent window area (window area) defined in the display screen where no active pixels exist (an "inactive area") and to locate the FCAM under it. The window area provides for a high optical transmissivity for the FCAM that is located under the display screen. For example, a circular window area (e.g., a display hole, blind-hole) can serve as a portal for the FCAM. When viewing the display screen, a user may see metal traces that create a reflective ring around the circular window area. The metal traces may be signal traces from the pixel layer (e.g., organic light-emitting diode (OLED)) or a touchscreen of the display screen. The metal traces may appear shiny, which can be distracting to the user and may interfere with the optimal operation of the FCAM.

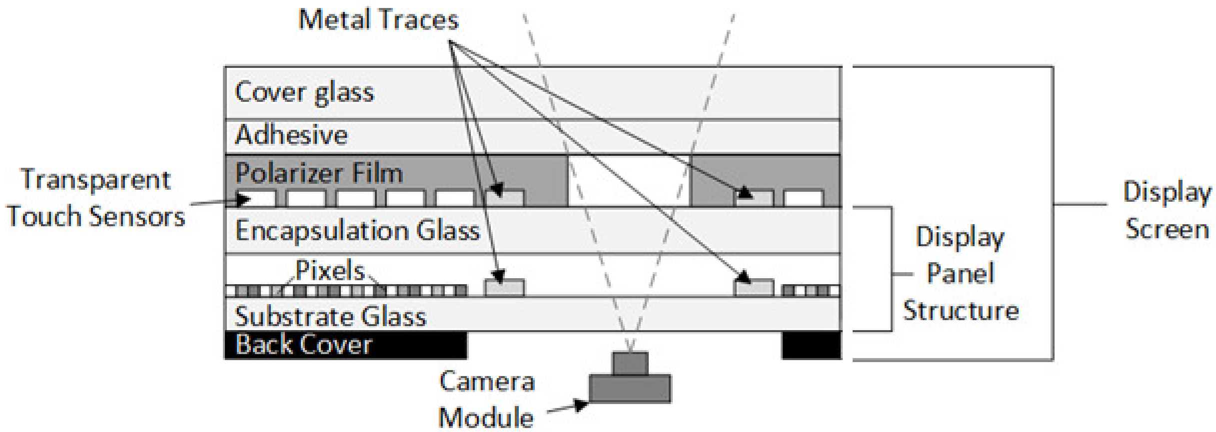

Figure 2

As illustrated in Figure 2, the metal traces may be covered with a polarizing film to eliminate the shiny appearance and to be more aesthetically pleasing to a user. However, due to the tolerances of the process of applying the polarizing film to the encapsulation glass, the polarizing film may extend beyond the metal traces and into the window area significantly (e.g., by 100 µm- 250 µm). As a result, the polarizing film may narrow the viewable area of the FCAM (indicated with dashed lines in Figure 2) and create a larger inactive area on the display screen (e.g., display blind spot).

Further, light emitted from the pixels of a display panel may impact an image sensor of the FCAM. For example, the encapsulation glass of the display screen can act like a lightguide to direct light emitted from the pixels to the edge of the window area. Thus, the image sensor may detect the light from the illuminated pixels as well as the light entering the window area from the intended view, which can create noise across a detected image.

Therefore, it is desirable to provide a user with a large, aesthetically pleasing display screen on an electronic device that maximizes the performance of the FCAM and decreases the impact of the lightguide effect on image quality.

Description:

This publication describes techniques and apparatuses for increasing camera performance and improving the aesthetic appearance of electronic device display screens with front facing cameras that utilize display screen blind-holes. The techniques include depositing a low-reflection or non-reflective material (collectively "black material") on metal signal traces (metal traces) located in an inactive area of a display panel module (e.g., display screen) of an electronic device. The black material increases the viewable area of a front-facing camera under a window area of the display screen and reduces the blind spot area where the display cannot have pixels. Further, the application of the black material to the metal traces eliminates the appearance of a shiny ring around the front-facing camera and reduces reflection to the FCAM, which improves camera performance.

Figure 3 illustrates a partial, schematic view of a display panel module of an electronic device. A cover glass layer (cover glass) is provided on the upper surface of the display panel module. The cover glass covers both an active area and a pixel-free inactive area of the display panel module. The cover glass, along with one or more polarizer film layers and/or touch sensor layers, is bonded, utilizing an optically clear adhesive (OCA), to the upper surface of a display panel structure of the display panel module (e.g., to the encapsulation glass). The display panel structure includes light-emitting red, green, and blue pixels. The camera module may be located under a window area where no active pixels exist in the display module for high optical transmissivity.

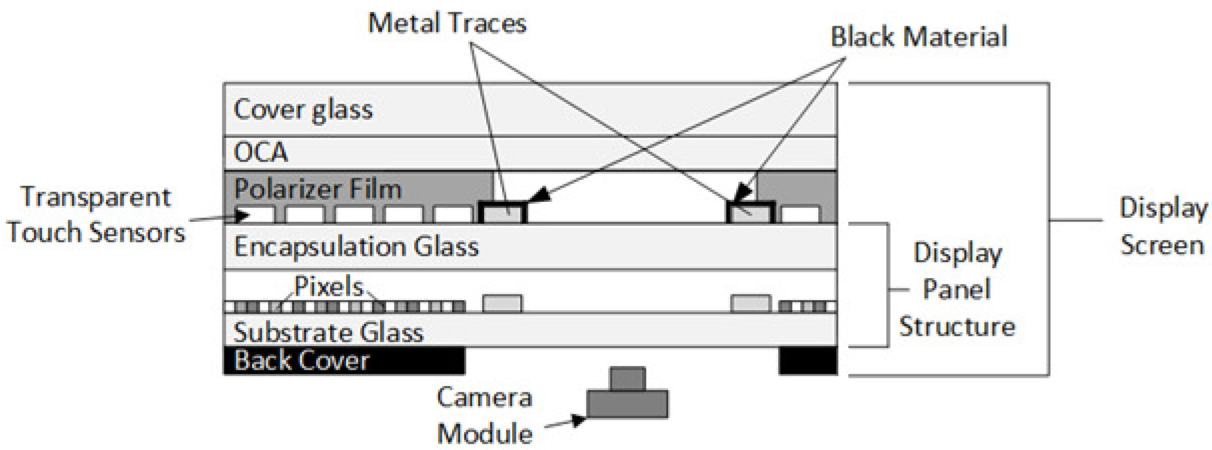

Figure 3

Referring to Figure 3, the reflective metal traces of the touch sensor layer located above the encapsulation glass of the display panel structure may be covered by a black material. The black material may be polymer, metallic, or another material. The black material may eliminate the need for a polarizing film to overlap the metal traces located around the window area. The black material deposited on the metal traces may eliminate the appearance of a shiny ring located around the window area for the camera module. The black material may be deposited and patterned by photo-lithography during a touch sensor patterning process. The alignment accuracy for depositing the black material may be high (e.g., < 1 µm) and the black material may be applied thin (e.g., < 5 µm).

The high tolerances of the manufacturing process for the application of the black material on the metal traces allows the field of view for the camera module to widen, as compared with the application of a polarizer film alone. As illustrated in Figure 3, the field of view for the camera module is not limited by the extension of the polarizer film into the window area, in comparison to the display screen illustrated in Figure 2.

The disclosed techniques and apparatuses may also increase the size of the active area of the display screen of the electronic device. With reference to Figure 4, additional pixels can be added to improve a user's viewing experience while maintaining the original field of view of the camera module (illustrated as dashed lines). Accordingly, with the black material deposited on the metal traces, the inactive area (e.g., display blind spot) of the display screen is reduced by about 30%.

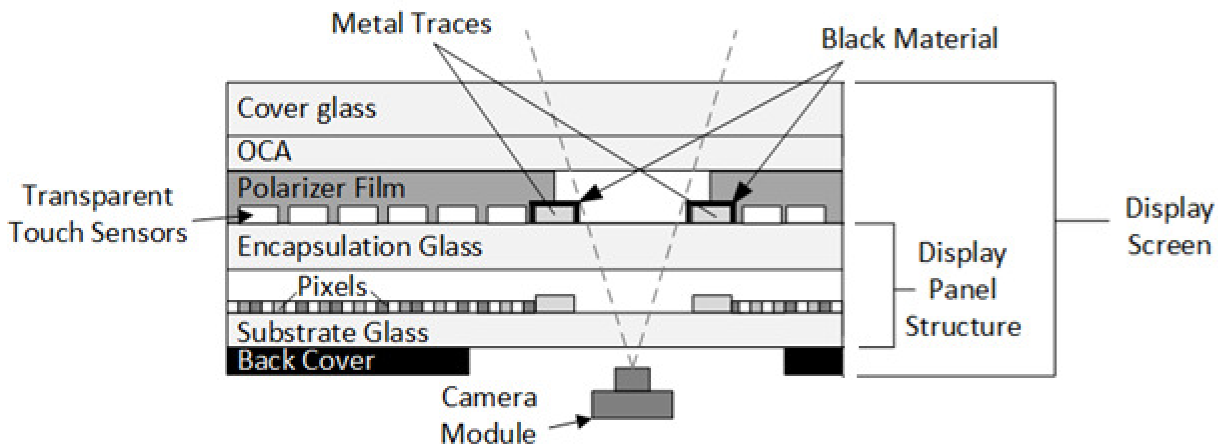

Figure 4

In another embodiment, the black material may reduce the reflection of light emitted by pixels into the camera module and improve camera imaging performance. Referring to Figure 5, the metal traces of touch sensors located on the encapsulation glass of the display panel structure may be narrowed. The black material may be deposited on the metal traces near the camera module and on top of the encapsulation glass around the window area for the camera module. The pattern of the black material may be more than 50% wider than a width of the reflective metal traces. The black material may be wide enough to cover the metal traces on the emissive layer located below it. The black material on the encapsulation glass can absorb light that is emitted from the pixels (illustrated as gray arrows). By reducing the reflection of emitted light into the camera module, the black material allows the camera module to capture better images with less noise.

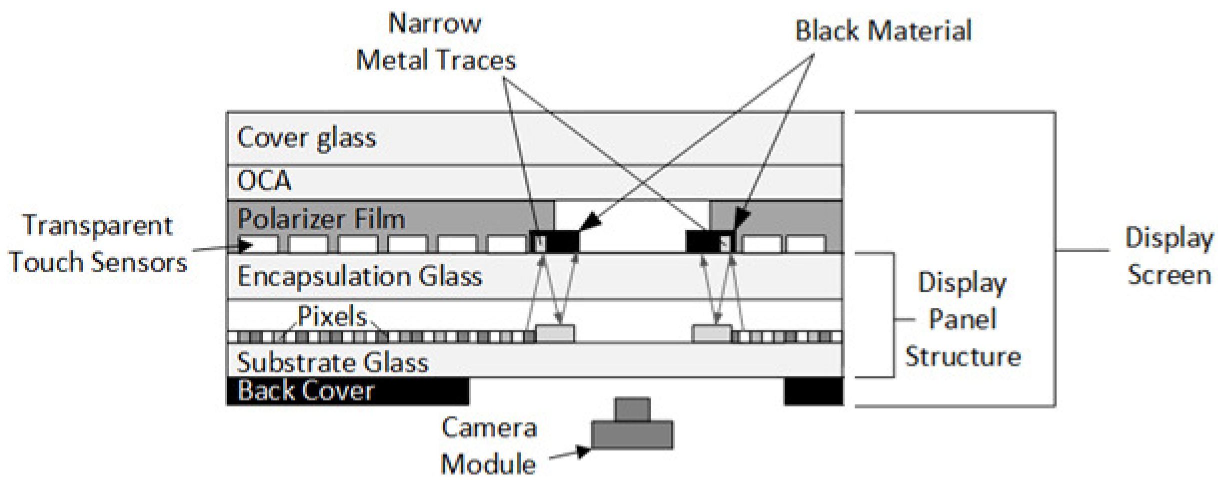

Figure 5

In another embodiment, the black material may be deposited on the bottom surface (e.g., on low-temperature polycrystalline silicone (LTPS)) of the encapsulation glass.

Referring to Figure 6, the black material may be deposited onto touch sensor reflective traces that are typical-sized.

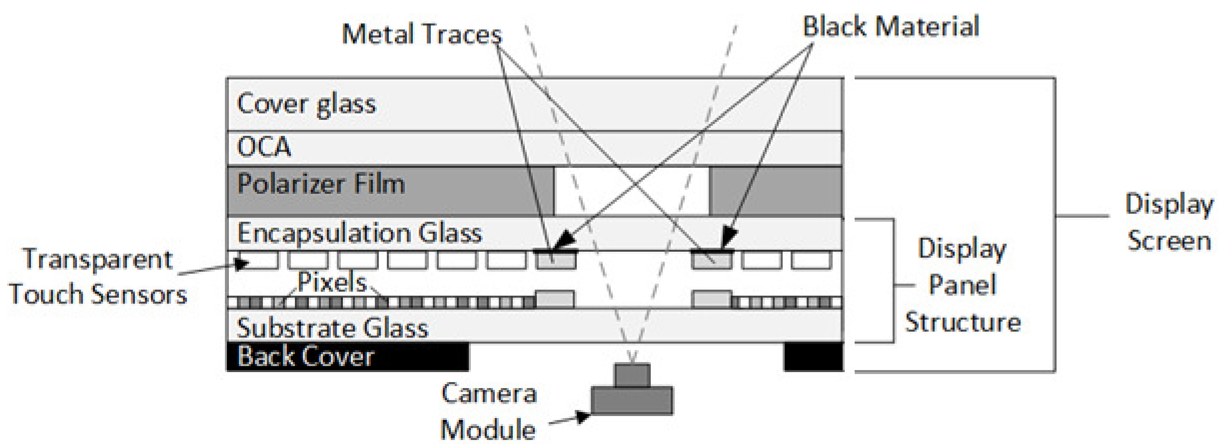

Figure 6

Referring to Figure 7, the black material may be deposited onto touch sensor reflective traces that are narrowed. The black material pattern may be more than 50% wider than the width of the touch sensor trace line and absorb reflections from the pixel layer. By reducing the reflection of pixel light into the camera module, the black material allows the camera module to capture better images.

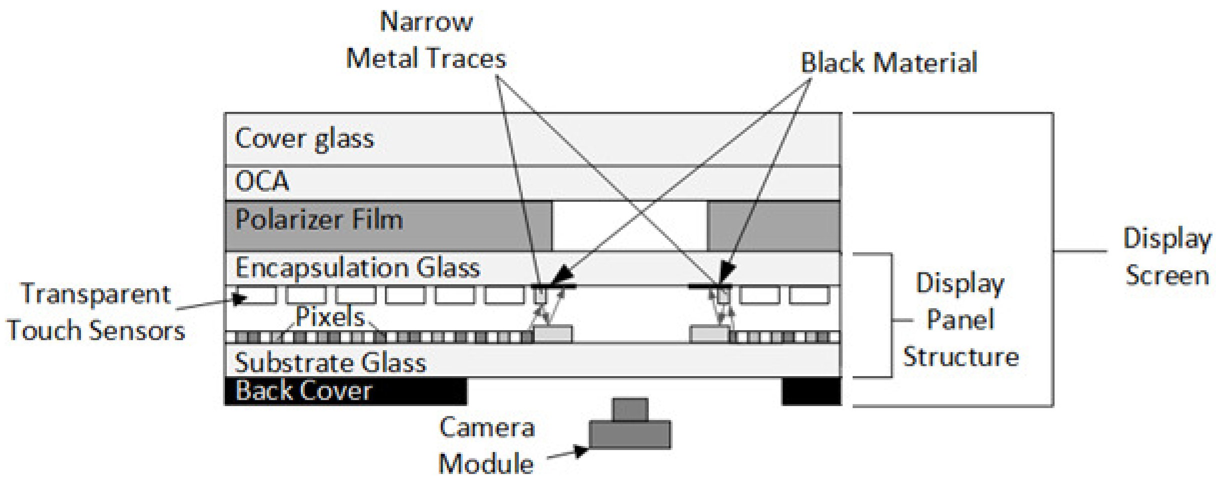

Figure 7

In summary, this publication describes the techniques and apparatuses for increasing camera performance and improving the aesthetic appearance of electronic device display screens with front facing cameras that utilize display screen blind-holes.

References:

[1] Patent Publication: US20210020698A1. OLED display device and method of manufacturing same. Priority Date: May 13, 2019.

[2] Patent Publication: US20190123112A1. Display device having black matrix. Priority Date: November 24, 2017.

[3] Patent Publication: WO2020215878A1. Under-screen camera assembly and corresponding organic light emitting diode display screen and terminal device. Priority Date: April 25, 2019.

[4] Patent Publication: US20160282987A1. Display Device. Priority Date: March 24, 2015.

[5] Patent Publication: US20160218151A1. Organic light emitting diode display and method of manufacturing the same. Priority Date: January 28, 2015.

[6] Patent Publication: US20110255000A1. Camera alignment and mounting structures. Priority Date: April 19, 2010.