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Study for Visual Color Improvement of an Organic Light Emitting Diode by a Dye-Polarizer

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A display is an interface containing information which stimulates human vision. Information may be pictures, animation, movies and articles. The new generation flat panel displays are able to process sufficient information content and operate in various applications. Among these candidates of new generation FPDs, OLEDs have many characteristic elements, such as a wide viewing angle, high contrast ratio, high color saturation and rapid response time. Therefore, OLEDs have recognized to be the next generation greatest potential display devices and planar lighting sources

Nowadays, the architecture design of the multi-layers is placed between the hole injecting anode and the electron injecting cathode. They are combined in something like a sandwich, including the hole injection layer (HIL), hole transporting layer (HTL), emitting layer (EML), electron transporting layer (ETL), and electron injection layer (EIL). Due to the cathode metals of OLEDs, they will lead to vigorous reflection in strong ambient light to decrease visual sensitivity, visual contrast, color and viewing angle chromatism of the screen image.

In the past, it was favored high light output of OLEDs for portable applications which is needed for readability in strong ambient light. Therefore, there are many methods for improving the out-coupling light efficiency of OLEDs. For example, a pyramidal array light-enhancing layer (pyramidal ALEL) on an OLED was optimized to enhance the luminance efficiency experimentally [1]. Furthermore, the rough or textured surfaces have been manufactured to suppress the waveguide modes and reduce the reflectance [2]. However, increasing high light emission compensate the reflection of ambient lights not enough to improve visual image performances and also lead to eyestrain and a short lifetime of the product. As some solutions to promoting the color gamut of OLEDs , various studies used the high efficient organic phosphorescent materials [3] to develop visual color saturation for OLEDs. However, they are more expensive and complex organic sandwich architectures than organic fluorescent materials. Another solutions for improving the color saturation of OLEDs, the color conversion method (CCM) and Color Filter (CF) was simultaneously used to progress the color saturation of a passive matrix OLED (PMOLED) [4], and the masked color filter (MCF) also was promoted to enhance the color performance [5], however, these technologies will lead to extra fabrication complexity and costs for making an OLED.

The multi-layer thin-films of OLEDs are deposited on the substrate, including the transparent anode, the organic multi-layers and the metal cathode. The reflectance of the panel of an OLED can be described by the theory of thin-film simulation which has a like transfer matrix of thin-film optical filters [6]. According to the result of the simulation, the reflective simulation of the panel of the OLED has a high amount of green reflective wavelength region (525nm ~ 580nm) for the visual sensitivity of human eyes. The proposed technique is a mature and convenient method to improve the image color improvement of an OLED that uses a functional optical film. A dye-circular-polarizer displays better transparency in the red and blue region and lower transparency in the green region in the visible light range, which was ratiocinated to improve the visual sensitivity of human eyes. The applied dye-circular-polarizer is the combination of a linear polarizer and a quarter-wave retarder. According to the applied study [7], it was able to improve the visual sensitivity of human eyes and reduce viewing angle chromatism when utilizing a dye-circular-polarizer on the panel of the OLED.

Presently, the biggest obstacles in developing and marketing OLEDs are expensive cost and immature supply chain, in comparison to LCDs. OLEDs is such an cost almost 7 times as much as LCDs' [8]. Although many efforts can improve the visual image performances, these improvement actions lead to extra cost and fabrication complexity. Utilizing dye-circular-polarizers on the panels of OLEDs is a convenient and mature technique which does not require the addition of extra technology. This method significantly improves the visual reflective sensitivity, contrast ratio and color saturation under strong ambient light conditions.

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