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Quantum Dots Transparent Display (QDs-TPD) Using N_2 Barrier Discharge with Liquid QDs Layer

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Extended Abstract

Transparent display (TPD) is an electronic information device that has gained rapidly growing attention recently. Its ability to represent images and texts on the transparent screen enables various applications such as handheld devices, sign boards, decorative windows, head up displays for vehicle and airplane, and information displays for medical and military purpose [1,2]. Various types of TPDs have been developed for suitable applications and each of them exhibits distinctive properties. In general, the TPD can be classified into two types: a see-through type and a projection type. The see-through type is again divided into an emissive and a passive type. The emissive type is a self-luminescence display including an organic electroluminescence display and an inorganic electroluminescence display; the passive type is a non-emissive display such as liquid crystal display, electro-wetting display, and electrochromic display. The emissive type displays represent perfect information under the dark environment, whereas the passive type displays do so under the bright environment. Thus, the emissive type displays in the bright environment must need visibility improvement, and the passive type display in the dark environment must require an edge type back light unit. In addition, the production of the TPD needs much improvement such as a scaling to large display sizes and a low-cost production. It is even necessary to develop new types of TPDs to acquire a high transparency and a high efficiency. The plasma discharge is a transparent medium with a specific color according to discharge gases, and the discharge mainly radiates strong UV and visible lights. In addition, the quantum dots (QDs) exhibit peculiar properties, such as a high luminescence, a color tenability, a strong chemical resistance, and a high dispersion property in liquids [3].

In this study, Quantum dots transparent display (QDs-TPD) was realized using a liquid QDs layer and N_2 barrier discharge panel. In the N_2 discharge, the 2nd$^+$ lines of N_2 in the range of 300 - 400 nm ($C^3\Pi_u$ - $B^3\Pi_g$), and the 1st$^-$ lines of N_2^+ at 391.4 and 427.8 nm ($B^2\Sigma_u^+$ - X^2 Σ_g^+) were mainly observed, while the visible emission lines were rarely observed. This implies the N_2 discharge is suitable for the excitation source of the QDs, due to the strong ultra-violet radiations and the weak visible emissions. The emission centers for red, green, and blue color in QDs-TPD were positioned at 452, 540, and 638 nm, respectively, and the N_2 emission peaks were seldom observed in the visible region. The transmittance of QDs-TPD was approximately 40% in the visible region and the luminescence was about 70 cd/m^2. The CIE (x, y) coordinates of red, green, and blue colors were (0.670, 0.309), (0.378, 0.640), and (0.183, 0.118), respectively, and the color gamut was 71% of a NTSC standard. Thus, the QDs-TPD is expected as a way for realizing the TPD, due to its good transparency, excellent visibility, wide viewing-angle, aesthetical design, low cost production, and good scalability to large sizes.

References

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