*Supplemental material*

Single electro-optic curve for RGB colours in blue-phase liquid crystal display

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The structures of the conventional LCD and FSC LCD with RGB LED backlight are drawn in Figure S1(a-d). For the conventional LCD, the colour image is obtained by mixing RGB sub-pixels, which is called as the spatial additive method. In contrast, the FSC LCD is achieved by rapidly displaying RGB images to obtain the colour image based on the persistence of vision effect, which method is named as temporal additive method. In comparison, the backlight of the conventional LCD usually utilizes the cold cathode fluorescent lamp (or white LED) with light guide plate. The colour filter absorbs 2/3 light intensity for each sub-pixel. Thus, the light intensity is reduced to ~33% [1-2]. There is no sub-pixel in FSC LCD, thus the resolution of the FSC LCD can be expanded by ~3×, as shown in Figure S1(b).

Figure S1(e) shows the mechanism of the FSC LCD by synthesizing a colour image. The data signal of red colour loads and the LC cell is driven to emerge the red image with different gray levels, and then the red LED backlight flashes. This is the process to display the red image. Then, the green and blue images emerge in turn. Finally, the colour image is synthesized by rapidly displaying RGB images. In these three processes, the RGB LED backlight arrays are lighted one by one, and the LC cell should be used to produce the images for every colour.

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Figure S1. (colour online) The diagrams of (a) the conventional RGB sub-pixel of LCD based on the spatial additive method, (b) the pixel of the FSC LCD based on temporal additive method. The structures of the (c) conventional LCD and (d) FSC LCD with RGB LED arrays. (e) The mechanism of the FSC LCD.

The protrusion’s height-dependent operating voltage curves of the proposed BPLCDs with various driving methods are provided in Figure S2 (for green colour) and Figure S3 (for blue colour). As a result, the protrusion’s height of 6 μm and driven by M3 driving method has the relatively low operating voltage for the proposed BPLCDs with various electrode’s sizes. Moreover, the operating voltage for red colour is larger than that for green colour, and the operating voltage for green colour is larger than that for blue colour with the same condition of electrode’s parameter and driving method.





Figure S2. (colour online) (a-d) Protrusion’s height-dependent operating voltage curves of BPLCDs with various electrode’s parameters for green colour.





Figure S3. (colour online) (a-d) Protrusion’s height-dependent operating voltage curves of BPLCDs with various electrode’s parameters for blue colour.

Figure S4 shows the normalized RGB VT curves of the proposed BPLCD with *w* = *l*/3 = 2 μm. The operating voltage for RGB colours are all 29.40 V. The maximum V*E*3 values for green and blue colours are pointed out in this figure.



Figure S4. (colour online) Normalized RGB VT curves of the proposed BPLCDs with *w* = *l*/3 = 2 μm.

**References**

[1] Lin FC, Huang YP, Wei CM, et al. Color filter-less LCDs in achieving high contrast and low power consumption by stencil field-sequential-color method. J Disp Technol. 2010;6:98-106.

[2] Yang DK, Wu ST. Fundamentals of liquid crystal devices. 2nd edition. New York, USA: John Wiley & Sons. 2014. Chapter 15, Liquid crystal display components; P. 513-536.