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Plastic-based dye-doped guest-host liquid crystal displays

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Flexible electronics that require roll-ability or fold-ability of substrates are great interest in numerous technology areas. A standard glass is lack of flexibility; however plastic substrates provide good robustness when dropped or twisted. Many anticipated benefits of flexible electronics to be thinner, flexible, potential to be large, more shock resistance, light in terms of weight, and cheaper than glass-based electronics.

The guest-host (GH) effect, the phenomenon of the alignment of dichroic dye molecules by liquid crystal molecules, was first reported by Heilmeier in 1968 [1]. A guest-host (GH) type liquid crystal display (LCD) device in which a dichroic dye is dissolved in a liquid crystal material has a large viewing angle, high brightness, daylight readability, and polarizer-free operation [2,3].

In this study, we demonstrate flexible polycarbonate (PC)-based red, green and blue GH-LCDs were fabricated and their electro-optic characteristics were investigated.

Dichroic dyes were dissolved in nematic liquid crystal (NLC). PC substrate coated with patterned indium zinc oxide were washed with neutral detergent, distilled water, and 2-propanol in an ultrasonic bath and then dried at 120 ^{o}C. Soluble poly (amic acid) as an alignment layer was spin-coated onto the IZO-coated PC and then thermally imidized by heat treatment.

The flexible GH-LCD cell was assembly using a pair of the substrate prepared above; these had been rubbed to obtain GH-LCD alignment. The gap of the GH-LCD cell was controlled by using 10μm thick glass ball spacer. Adhesive seal line for assembling the cells was drawn by an automatic dispenser (Musashi MINI200SD) on the bottom substrate, and then cured by UV irradiation. GH-LC was introduced into the cell by mean of modified ODF (one drop filling) method. To obtain the color reflective GH-LCD, we used a polarized reflective film as a reflector.

To prepare GH-LCD devices, a dichroic dye with red, blue, green color that has a high solubility and large dichroic ratio mixed as a guest in the host NLC phase under room temperature. The GH-LCDs exhibit good hue angle and chromic value in LAB color space. The GH-LC molecules in the cell without an electric field are aligned parallel to the PC substrate (homogenous alignment) and thus they exhibit maximum absorption value.

We explored the change in alignment of GH-LC with red, blue, green dyes using an electric field. It was observed that with increasing applied a.c. voltage across the cell, the color of GH-LCD decreased steeply and eventually reached transparent phase. In GH-LCDs fabrication process, much attention was paid to the maximum concentration of dyes, dye mixing steps, time between GH-LC prepared to GH-LC filling, width of seal line and assembly conditions.

The flexible GH-LCD clock cell operated at transparent and absorptive states without polarizers and backlight are shown in Figure 1. Fig 1 shows the GH-LCD clock driven a.c. bias voltage (50Hz) of 4.0V. the response time of the cell, rising and falling times were 7 ms and 66 ms, was 73ms, respectively.

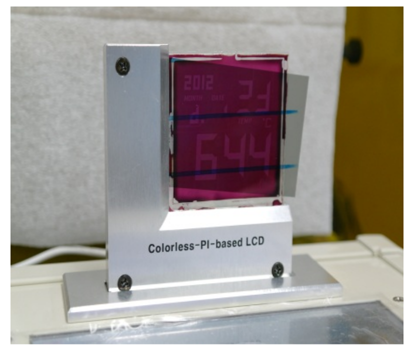

Figure 1 GH-LCD Clock

References

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