

Design method for transmittance control of a guest-host liquid crystal cell

Seung-Min Nam¹, Seung-Won Oh¹, Sang-Hyeok Kim¹, Jae-Won Huh¹, Eunjung Lim², Jinhong Kim², and Tae-Hoon Yoon^{1,*}

¹Department of Electronics Engineering, Pusan National University, Busan 46241, Korea

²LG Chem R&D Campus Daejeon, Daejeon, 34122, Korea

* thyoon@pusan.ac.kr

Abstract— A transmittance-control device requires a high transmittance difference between its transparent and opaque states. In this paper, we propose a systematic approach to find the condition for the maximum transmittance difference in a guest-host liquid crystal cell.

I. Introduction

Transmittance-control devices allow users to control the transmitted light intensity through the absorption of the incident light. These devices have been widely studied for eyewear, smart windows, and automotive applications. Guest-host liquid crystal (GHLC) devices are widely used for fast transmittance control [1-3]. They require a high transmittance difference between their transparent and opaque states. Therefore, it is necessary to study the condition for the maximum transmittance difference between the transparent and opaque states while satisfying the desired performance, such as the response time, driving voltage, and saturation concentration of dye.

In this study, we present a systematic approach to find the condition for the desired transmittance difference in a GHLC device. We calculated the transmittance difference as we varied the cell gap and dye concentration. In the proposed process, we can determine the cell gap and dye concentration with the desired performance. Therefore, by using the proposed process, we can systematically obtain the condition for the desired GHLC cell before cell fabrication.

II. Results and Discussion

We calculated the transmittance difference of electrically-controlled-birefringence (ECB) and cholesteric LC (ChLC) cells. To find the condition for the maximum transmittance difference, we plotted the constant transmittance-difference contour maps on the parameter space of the cell gap and dye concentration.

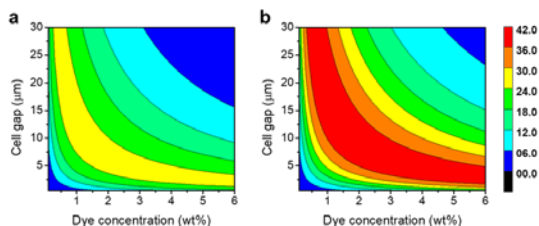


Fig. 1. Constant transmittance-difference contour maps of (a) ECB and (b) ChLC cells on the parameter space.

Using the above constant transmittance-difference contour maps, we introduce how to design a GHLC cell. The design process is as follows: i) Choose the appropriate LC mode considering the application. ii) exclude the condition that cannot satisfy the minimum transmittance in the transparent state. iii) determine the maximum cell gap considering the response time or driving voltage and the maximum dye concentration, considering the saturation concentration of the dye to be mixed with the used LCs. and iv) select the condition for the maximum transmittance difference (Fig. 2).

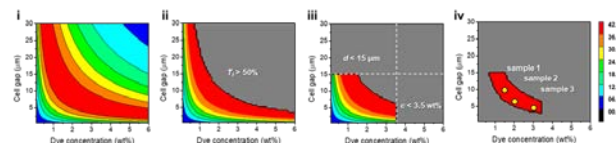


Fig. 2. Example of the proposed design process of a ChLC cell on a constant transmittance-difference contour map.

III. Conclusion

We confirmed experimentally that the design of a GHLC cell with the desired performance could be achieved through the proposed design process. We expect that the proposed approach will offer an effective method for the fabrication of a GHLC cell that can be used to control the transmittance.

Acknowledgments This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIP) (No. 2017R1A2A1A05001067).

References

- [1] S.-W. Oh, J.-M. Baek, J. Heo, and T.-H. Yoon, "Dye-doped cholesteric liquid crystal light shutter with a polymer-dispersed liquid crystal film", *Dye. Pigment.* 134, 36-40 (2016).
- [2] J.-W. Huh, B.-H. Yu, J. Heo, S.-M. Ji, and T.-H. Yoon, "Technologies for display application of liquid crystal light shutters", *Mol. Cryst. Liq. Cryst.* 664(1), 120-129 (2017).
- [3] S.-H. Kim, S.-W. Oh, and T.-H. Yoon, "Enhancement of absorption and haze with hybrid anchoring of dye-doped cholesteric liquid crystals", *Opt. Express* 26(11), 14259 (2018).