Control of Reflected Color in Cholesteric Liquid Crystal-Polymer Composite System for Display Applications

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The helical structure of cholesteric liquid crystals (CLCs) has attracted much attention since the wavelength-selective reflection corresponding to the helical pitch of the CLCs [1]. In principle, the reflected color of the CLCs results from Bragg reflection from the helical structure of the CLCs, whose the pitch is controlled by concentration of a chiral agent and temperature. Such color selecctivity of the CLCs is applicable to reflective color displays without polarizer and color filter. However, since the pitch of the CLCs is intrinsically varied by temperature, the pitch stabilization of the CLC against temperature is important issue in deivce applications of the CLCs. The various approaches have been explored by introducing photopolymer to the CLCs [2-5]. In the polymer/CLC composite systems, the polymer structure inhibites the pitch variation of the CLC by temperature and thus the CLC pitch formed at different temperature is stabilized. Through the selective polymerization at different temperature, multi-color CLC displays are realized even in a single-layered configuration. Also, the CLC pitches are varied by ultra-violet (UV) intensity due to the phase separation between polymer and CLC. In the CLC composite systems with photocurable monomers, UV intensity gradient generates the pitch gradient normal to the UV incident direction covering whole visible range [6].

In this work, we introduce a mechanism of the pitch variation in the polymer/CLC composite systems based on the concentration gradients of the chiral dopant and photopolymer. The UV intensity gradient, caused by UV absorption of the photocurable monomer and CLC molecule, produces the concentration variations of photopolymer and chiral dopant, and thus the resulant pitch gradient was obtained. We demonstrate a transflective display using the white reflector with broadband reflection spectrum based on the stabilization of the continuous varying pitch in the vertical direction to the substrates [7]. Also, the multi-color CLC display in a single-layered configuration is fabricated based on the multi-pitch stabilization by selective UV exposure at different temperature through shifting photomask [5].

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References

1. P. G. de Gennes and J. Prost, The Physics of Liquid Crystals, Oxford University Press, NewYork (1995).
2. G. de Filpo, F. P. Nicoletta, and G. Chidichimo, *Adv. Mater.* 17, 1150 (2005).
3. J. Chen, S. M. Morris, T. D. Wilkinson, and H. J. Coles, *Appl. Phys. Lett.* 91, 121118 (2007).
4. S.-Y. Lu and L.-C. Chien, *Appl. Phys. Lett.* 91, 131119 (2007).
5. K. S. Bae, Y. J. Jang, Y. K. Moon, S. G. Kang, U. Cha, C. J. Yu, J. E. Jang, J. E. Jung, and J.-H. Kim, *Jpn. J. Appl. Phys.* 49, 084103 (2010).
6. D. J. Broer, J. Lub, and G. N. Mol, *Nature* 378, 467–469 (1995).
7. K.-S. Bae, U. Cha, Y.-J. Lee, Y.-K. Moon, H. C. Choi, J.-H. Kim, C.-J. Yu, *Opt. Express* 19, 8291 (2011).