1차원 포토닉 밴드갭 콜레스테릭 액정의 비선형 광학적 변화

Nonlinear Optical Changes in 1-D Photonic Band Gaps of Cholesteric Liquid Crystal

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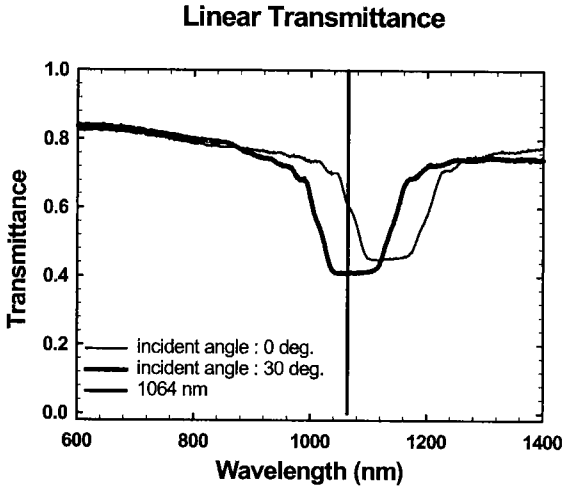
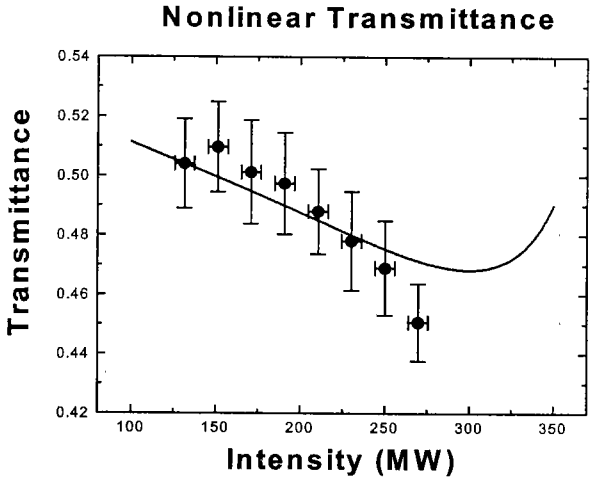
We studied optical Kerr nonlinearity in the vicinity of 1-D photonic band gap edge of a cholesteric liquid crystal system. Through experimental measurements, we observed the changes in the width and the position of the photonic band gap as a function of laser intensity in a cholesteric liquid crystal, which has a 1-D photonic crystal structure.

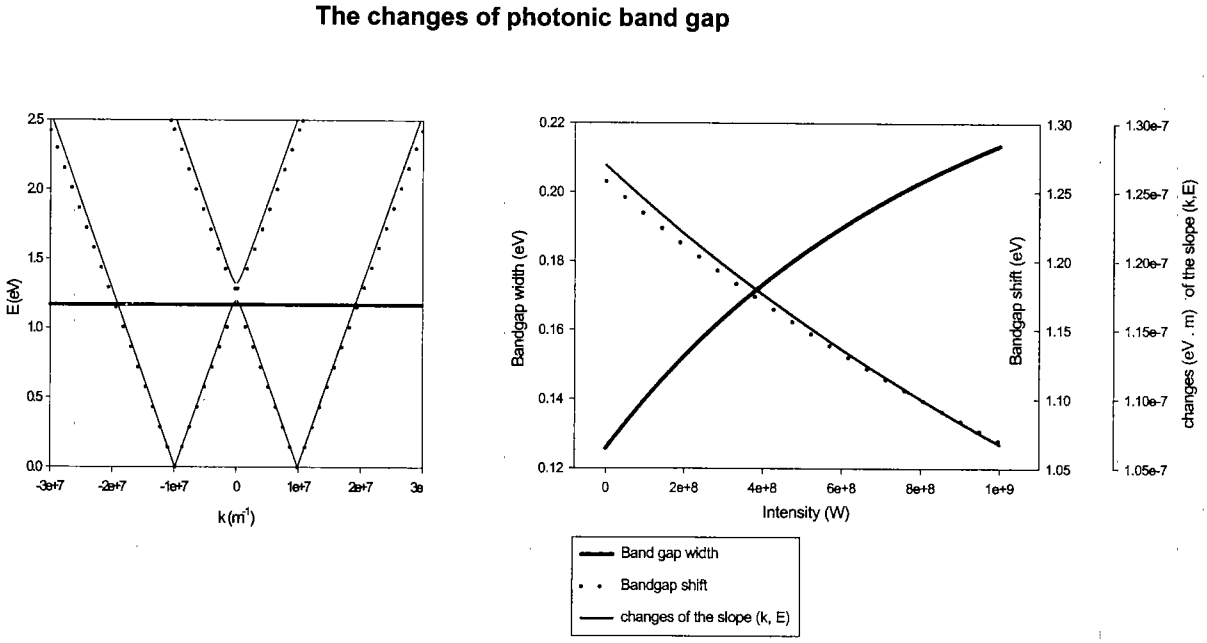
A cholesteric liquid crystal cell was fabricated possessing 1-D photonic band gap structure. From the measurement of the linear absorption spectrum of the cell, the existence of a band gap was identified. The center of band gap was located at 1.08 eV (1143 nm) with the gap width of 0.1 eV (100 nm). The propagation of light in the cholesteric liquid crystal was analyzed by Berreman's 4×4 matrix method. Based on the linear absorption spectra, the dispersion of the principal refractive indices along the parallel and perpendicular direction of the molecule was determined. At the wavelength of 1064 nm, the linear refractive indices were found to be 1.631 and 1.476 along the parallel and perpendicular directions of the molecule.

A Q-switched Nd:YAG laser (1064nm) was employed to investigate the nonlinear optical changes in the position and width of photonic band gap. With the incident angle of 30 degrees, the right edge of the band gap (when plotted in wavelength) fell on the wavelength of 1064 nm. As the laser intensity was increased to 320 MW per squared cm, the transmission decreased from 0.51 and 0.47, corresponding to an 8% change. The nonlinear transmission change was analysed numerically by Berreman's 4×4 matrix method with the incorporation of Kerr nonlinearity in the optical response of the molecules forming choleteric liquid crystal. The changes in the refractive indices long the parallel and perpendicular directions were 3.46 and 1.51 times 10 to the minus 10 (squared cm per Watt), which is about 3 orders of magnitude larger than a typical third order nonlinearity of organic molecule. The enhancement is presumably from the increase of the density of states near the band edge of the photonic band gap. The analysis showed that the changes in the

position and width of band gap are 0.02 eV and 0.03 eV at the laser intensity of 320 MW per squared cm. This observation opens the possibility of optical tuning of band gaps in 1-D photonic crystal structures.







References

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