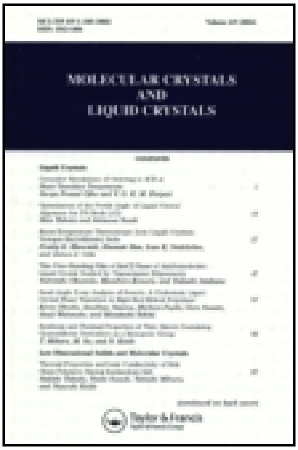

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T. Cesarz [a], S. Klosowicz [b], E. Nowinowski-kruszelnicki [b] & J. Zmija [b]

[a] Kaliski Institute of laser Microfusion and Plasma Physics, ul. Radiowa, Warsaw, POLAND

[b] Institute of Technical Physics WAT, ul. Kaliskiego, 00908, Warsaw, POLAND

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LIQUID CRYSTAL ELEMENTS OF LASER OPTICS. THE OPTICAL ISOLATOR

TADEUSZ CESARZ[+], STANISŁAW KŁOSOWICZ[x], EDWARD NOWINOWSKI-KRUSZELNICKI[x] AND JÓZEF ŻMIJA[x]
[+]Kaliski Institute of Laser Microfusion and Plasma Physics, ul. Radiowa, Warsaw, POLAND.
[x]Institute of Technical Physics WAT, ul. Kaliskiego, 00908 Warsaw, POLAND.

Abstract The studies have been done on the possibility of liquid crystals application for the optical isolation of laser systems. The appropriate elements containing different mesogenic materials have been made. The results suggest that these elements are very useful in laser systems.

INTRODUCTION

In the case of the interaction of high-power-laser-radiation with the target the protection of laser is necessary. The part of reflected beam returns to the generating system and can damage the optical elements. The task of the optical isolators placed in the beam path is the transmission of radiation emitted and high damping of returned beam. Up to now the Faraday's rotators have been used as the optical isolators[1]. Recent results suggest that the same role can play the thin planar layer of cholesteric liquid crystal (CLC).

The liquid-crystal-optical-isolator (LCOI) works on the base of well-known effects: the circular dichroism and the selective light reflection. The CLC layer reflects the circular polarized wave having the polarization sense the same as the CLC helical twist sense and transmits the wave having the opposite sense of polarization.

EXPERIMENTAL

All studies have been done for YAG:Nd^{3+} laser with wavelength λ_0=1.06 μm which worked in normal mode (τ_i=0.3 ms), Q-switched mode (τ_i=30 ns) and rejected pulse mode (τ_i=1 ns). The λ_0 of CLC mixtures have been controlled by means of Beckman 5170 spectrofotometer.

Because of temperature histeresis and strong temperature dependence of λ_0 of cholesterol ester mixtures the studies have been done for the mixtures of nematic and chiral compound: hexylcyanobiphenyl + cholesterol chloride (A), Merck Licristal ZLI-2457 + 4,4'-di(2-methyl)butyloazoxybenzene (B) and W5CL3 made by WAT (C).

The example of temperature dependence of λ_0 is shown in Fig.1. For these mixtures the values of transmission coefficients t^+ for the mode with the circular polarization sense the same as the helical twist sense and t^- for the opposite mode have been measured by the system shown in Fig.2. Then the contrast ratio

$$K=\frac{t^-}{t^+} \tag{1}$$

has been calculated (see Fig.3). The experimental error of K was 5 per cent and reproducibility was 10 per cent. The cells with different thickness and surface conditions have been made by common LCD technology.

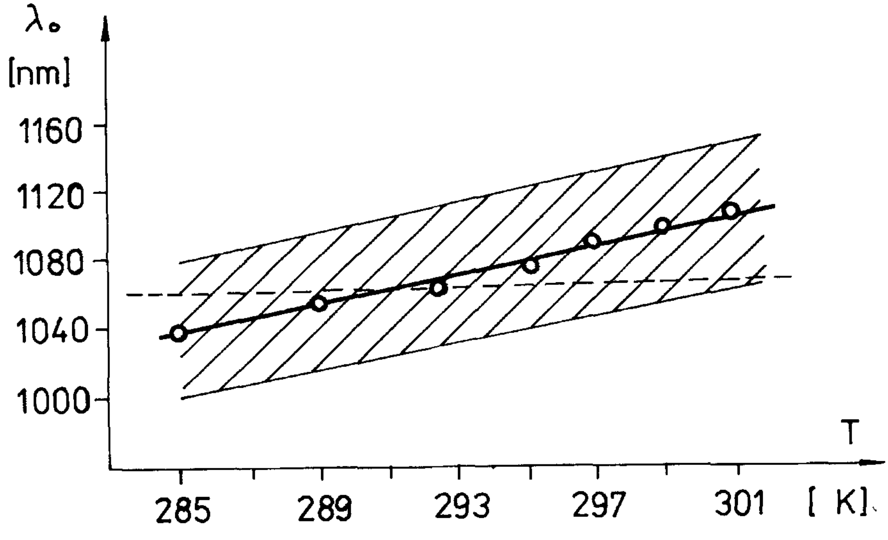

FIGURE 1. The temperature dependence of λ_0 for mixture. The spectral range of selective reflection is shaded.

The contrast ratio of CLC depends on the beam ellipticity

$$\varepsilon = \frac{E^1}{E^2}, \qquad (2)$$

where E^1 and E^2 are the radiation energies measured parallelly to shorter and longer axis of polarization ellipse, respectively. The ε has been changed by adjusting of the voltage on the Pockels' cell (see Fig.4).

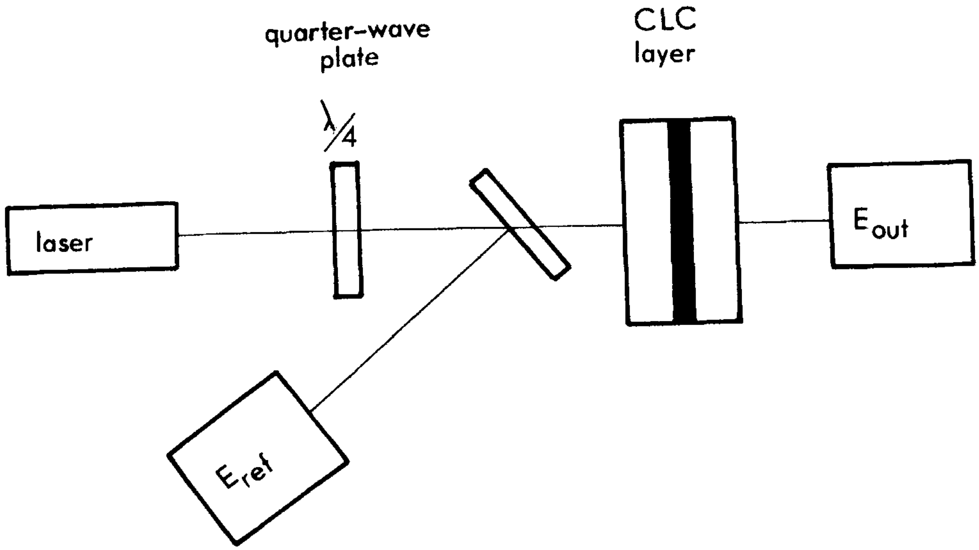

FIGURE 2. The system for contrast ratio measurements.

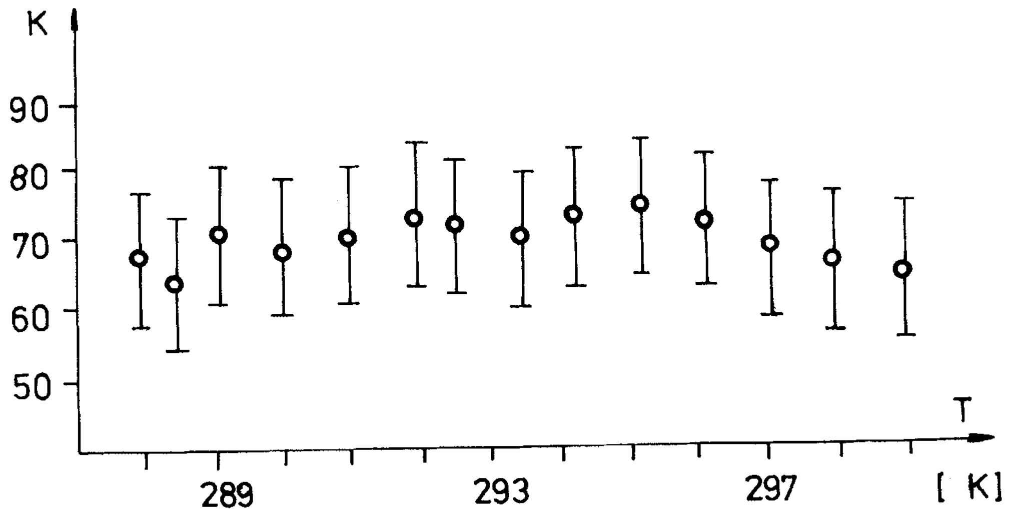

FIGURE 3. The temperature dependence of K for 12 μm thick layer of the mixture C.

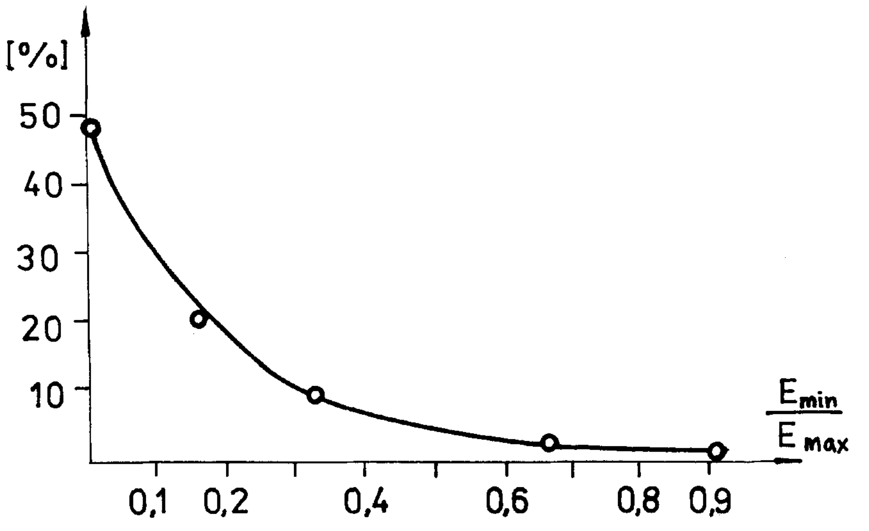

FIGURE 4. The beam ellipticity dependence of total transmission of 12 μm thick layer of the mixture C.

CONCLUSIONS

The values of contrast ratio were 50-70. They were independent o temperature and angle up to 7 angle degrees. They were higher for mosaic layers than for strictly planar layers. The maximum values of K were obtained for layers 30 μm, but the thickness dependence of K was relatively weak. The shorter were τ_i, the lower was K. The LCOI has many adventages: simple technology, low cost, high aperture, absence of power supply, high contrast ratio.

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