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Photoinduced anchoring on a chalcogenide surface

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We present basic characteristics and a model of photoinduced anchoring of liquid crystals (LCs) on a chalcogenide surface. It was found that characteristics of the alignment strongly depend on the LC material for the same chalcogenide glass. The photoalignment is partially reversible and can be controlled by changing the light polarization direction. We propose a model in which the existence of dichroic units on the chalcogenide surface and competition between two mechanisms of the photoalignment is suggested. The first mechanism is related to the light-induced anisotropy on the chalcogenide surface and results in an easy orientation axes of a LC parallel to the polarization of the incident light. The second mechanism is attributed to an energy transfer from the dichroic units after the light absorption to the LC molecules adsorbed on the chalcogenide surface. The transferred energy causes polarization-sensitive desorption of the LC molecules from the chalcogenide surface and the light-induced easy orientation axis of a LC perpendicular to the incident light polarization. The competition between these mechanisms leads to the observed change of the direction of the easy axis with the exposure.

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I. INTRODUCTION

The introduction of the effect of photoalignment of liquid crystals at the beginning of the 1990s [1–3] opened astonishing possibilities in the definition and control of bulk LC orientation affected by boundary conditions using polarized light. Effective control of the direction of the alignment, pretilt angle, and anchoring energy by polarized light irradiation and the possibility of alignment on curved and flexible substrates and in confined volumes made the photoalignment technology an indispensable tool. Applications of this approach in modern LC-based photonic devices include electrically controlled Fresnel lenses [4,5], polarization convertors [6,7], optical gratings [8,9], and waveguides [10].

The physical reason for the photoalignment of LCs is the formation of a light-induced anisotropy axis on the boundary surface. The angularly dependent interaction of the LC molecules with the light-induced anisotropy axis results in their preferable alignment along this axis. This alignment extends to the LC bulk on macroscopic length scales. The microscopic mechanisms of formation of the anisotropy axis on the boundary surface can be divided into two groups [11]. In the first group the anisotropy axis is formed due to various effects of photoinduced anisotropy in the boundary material [12,13]. To observe this kind of photoalignment, the aligning material is usually irradiated *before* the cell is filled. In the second group the anisotropy axis is formed in a layer of molecules adsorbed on the boundary surface. The anisotropy in a layer of adsorbed molecules can be realized by light-induced desorption of the LC molecules [14] or be a result of the competition between light-induced adsorption and desorption of dye molecules dissolved in a LC [15–17]. Both absorption and desorption mechanisms are related to the *absorption of the polarized light by a LC*. Their action is observed as the cell is irradiated *after* its filling. In the present paper we show that anisotropy in a layer of adsorbed LC molecules also can be induced by *absorption of the polarized light by an aligning layer*. This new photoalignment effect was found in LC cells with a chalcogenide aligning surface.

The first observation of photoalignment on chalcogenide glass was by Kurioz *et al.*, who observed a light irradiation of the chalcogenide surface through a layer of a LC in isotropic phase after the cell was filled [18]. This effect was used for recording of holographic gratings in a LC cell. Later Gelbaor *et al.* observed light-induced alignment following the irradiation of a chalcogenide film before the cell was filled [19]. Here we show that photoalignment in the filled cell is a result of competition between light-induced anisotropy in a chalcogenide film [19] and light-induced desorption of the adsorbed molecules due to an energy transfer from the chalcogenide to the adsorbed molecules after the light is absorbed.

The paper is organized as follows. In the first part we describe the experiments that demonstrate the difference between the photoalignment processes when the chalcogenide film is irradiated before and after the cell filling. The results of these experiments allow us to suggest that the layer of adsorbed LC molecules plays a crucial role in the photoalignment mechanism in the filled cell. In the second part we describe additional experiments that confirm this idea and demonstrate that the photoalignment in the filled cell is caused by absorption of light in the chalcogenide film followed by desorption of LC molecules from the chalcogenide surface. Based on experimental results, we propose a microscopic model for the photoalignment that explains the experimental data.

II. MATERIALS AND EXPERIMENTS

We used chalcogenide glass films As_2S_3 (thickness $d = 20$ nm) in the experiments. The films were fabricated according to the method of Ref. [19] by thermal evaporation of

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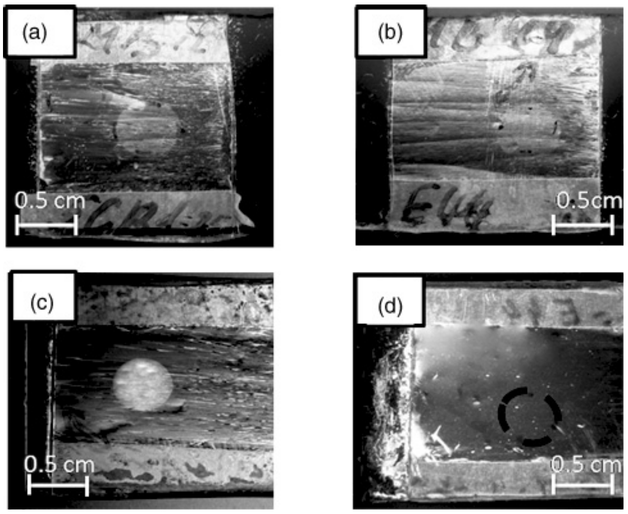

FIG. 1. Images in crossed polarizers. The directions of the rubbing on the reference surfaces are parallel to the polarizers axes $\tau_{\text{exp}} = 30$ min. Top row: cell with LC 5CB (a) and cell with LC E 44 (b) were irradiated before filling. Bottom row: cell with LC 5CB (c) and cell with LC E44 (d) were irradiated after filling.

commercially available As_2S_3 glass (Amorphous Materials, Garland, TX) from quartz crucibles onto the clean glass substrates in vacuum $\sim$(2–5) 10^{-6} Torr. The deposition was done with a source to substrate distance of 30 cm at a typical rate of 0.2–0.3 nm/s [19]. As-evaporated films without further heat treatment were used in the experiments. The films had band gaps of 2.35–2.4 eV, and effectively absorb light with wavelength, $\lambda < 520$ nm [20].

For LCs we used pentyl-cyanobiphenyl (5CB) (Institute of Single Crystals, Kharkiv, Ukraine) and the commercial nematic mixture E44 (Merck). First, we reproduced the results of Gelbaor *et al.* [19] by irradiation of the chalcogenide surface with polarized light from a mercury lamp through a filter ($\lambda = 436.6$ nm), having an intensity $I_{\text{pump}} \approx 2.2 \times 10^2$ W/m^2. The exposure time was $\tau_{\text{exp}} = 1$ to 60 min. The wavelength $\lambda = 436.6$ nm corresponds to the absorption band of the chalcogenide layer. The irradiated chalcogenide film was used as one of the substrates ("tested substrate") of the combined cell. The other substrate ("reference substrate") was covered by rubbed polyimide that provided strong planar alignment with a small pretilt ($\sim 2^\circ$) of the LC director along the rubbing direction. The test and reference substrates were assembled in such a way that the polarization of UV light ($\vec{E}_{\text{UV}}$) during irradiation was at an angle $\phi = \pi/4$ with respect to the direction of rubbing on the reference surface. In this geometry the surface anisotropy on the tested substrate, if any, was expected to lead to formation of twisted LC textures in the irradiated areas. The thickness of cells was $d = 20$ to 28 μm.

The cells with irradiated chalcogenide layers were filled immediately by capillary forces after the irradiation with the LCs at room temperature. The twisted structures with a twist angle of $\phi \approx 18^\circ$ for 5CB and $\phi \approx 12^\circ$ for E44 with respect to the direction of the director $\vec{n}$ on the reference substrate were observed [Figs. 1(a) and 1(b)]. The contrast of the light-induced twisted textures was low and the photo-orientation was not perfectly homogeneous. The sign of the director twist was in the direction of the light-induced easy axis parallel to the polarization $\vec{E}_{\text{UV}}$, which corresponded to the results of Gelbaor *et al.* [19].

It is interesting to note that we did not find any traces of the light-induced twisted structures when we filled the cells in the isotropic phase and then cooled them down to the nematic phase. In these experiments the cells were placed on a hot metal block with the reference rubbed substrates facing up, and then slowly cooled to the room temperature over approximately 30 min. For these conditions the transition to the nematic phase started from the reference substrate, which defines the alignment of the LC in the cell in this case. Observations using a polarizing microscope did not reveal any difference between irradiated and nonirradiated areas for the entire range of the exposure times in all of the cells; the cells demonstrated an inhomogeneous planar alignment with average direction of $\vec{n}$ parallel to the rubbing direction. Also, cooling of the cells in a magnetic field parallel to the rubbing direction on the reference substrate did not result in the photoalignment of the LC in the cell. These experiments point to weak anchoring of the LCs on the chalcogenide surfaces that were irradiated before the filling of the cells [21].

On the other hand, if the cells were irradiated after they were filled with LC 5CB, we observed a pronounced homogeneous twisted structures in the irradiated areas [Fig. 1(c)], which were stable in time. At the same time we did not observe any traces of twisted structures in the cells filled with the LC E44 [Fig. 1(d)].

The qualitative results depicted in Figs. 1(a)–1(d) clearly demonstrate the ability of effective photoalignment of LCs on the chalcogenide surface for *in situ* irradiation and show that this ability is different for different LCs.

In our experiments, the Mauguin regime [22] for propagation of polarized light through the cells was valid. In this case the polarization of a probe input beam, which was initially parallel to the rubbing direction, follows the director structure in the cell, and the angle between the polarizations of the input and output beams is equal to the light-induced twist angle ϕ_o. This allowed us to measure the dependences of the photoinduced twist angle on both the exposure dose (integrated incident power per unite area) and time in the 5CB cells using a polarizing microscope (Fig. 2). We define the sign of the twist angle $\phi_o > 0$ for reorientation of the director towards the light polarization direction $\vec{E}_{\text{UV}}$ from the initial position and $\phi_o < 0$ for reorientation away from the vector $\vec{E}_{\text{UV}}$.

One can see that in the case of 5CB, the twist angle $\phi_o > 0$ for the first 2 min of exposure ($\tau_{\text{exp}} \leqslant 2$ min) and $\phi_o < 0$ thereafter ($\tau_{\text{exp}} \geqslant 2$ min). The maximum observed value of the photoinduced twist angle was around -35°. The reorientation towards $\vec{E}_{\text{UV}}$ corresponds to the observations of the photoalignment of the chalcogenide by Gelbaor *et al.* [19] (irradiation before cell filling), and the reorientation away from $\vec{E}_{\text{UV}}$ suggests another photoalignment mechanism at $\tau_{\text{exp}} \geqslant 2$ min.

The light-induced alignment of 5CB is partially reversible. In Fig. 3 we demonstrate the dependence of the light-induced twist angle on the number of irradiation cycles with alternating polarizations $\phi = \pm\pi/4$.

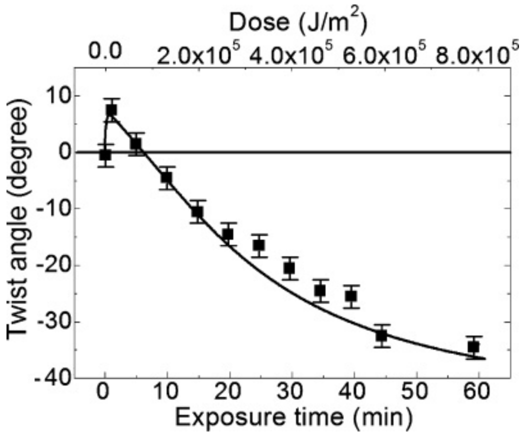

FIG. 2. Experimental (points) and theoretical (solid curve) dependences of twist angle of LC 5CB on As_2S_3 layer on incident light dose and exposure time.

III. ADDITIONAL EXPERIMENTS AND DISCUSSION

The key result of our experiments is that efficient photoalignment of LCs on chalcogenide surface requires the presence of a LC during irradiation—the exposure of the chalcogenide should be performed in the filled LC cell. These facts, together with the temporal stability of the photoalignment, allow us to assume that the effect is related to the layer of LC molecules that is adsorbed on the chalcogenide surface.

The mechanism of the adsorption of 5CB molecules on the chalcogenide surface requires additional studies. For now we can suggest that the adsorption is due to interaction between the one of the benzene ring of the 5CB molecule and the covalent bond of chalcogenide, which characteristic size (0.2–0.4 nm) are close to the diameter of a benzene ring 0.3 nm. A benzene ring is a good electrons' acceptor and can form a coordinate bond with the covalent bonds of the chalcogenide and valence-alteration pairs of As and S atoms. Moreover, since the angle between the benzene rings of a 5CB molecule is rather high (around 28^o), only one of the two rings interact with the covalent bond efficiently. Thus, the adsorption of a 5CB molecule occurs due to interaction of the one covalent bond and the one benzene ring of 5CB molecule.

To check if this layer can serve as an aligning layer for the bulk LC, we filled a cell constructed of two identical As_2S_3 substrates with the LC 5CB at $T > T_C$ and cooled it down to room temperature in a magnetic field ($\vec{H} = 8.5$ kOe). The cell revealed excellent spatially homogenous planar alignment of the LC parallel to $\vec{H}$, which remained highly homogeneous after the reheating above T_C and subsequent cooling of the cell. We explain this result by the formation of a stable aligning layer of the adsorbed LC molecules on the chalcogenide surface.

It is known that polarization-sensitive light-induced desorption of LC molecules or dye molecules can change the easy orientation axis on the surface [14–16]. Thus, we speculate that a similar effect takes place in our case. The energy that initiates desorption of the LC molecules comes from light absorbed either by LC molecules themselves [14] or by the chalcogenide film. To understand which of these scenarios takes place, we carried out the following experiments.

First, we verified the possibility of photoalignment of the LC 5CB on a pure glass surface, that is, on a material that is fully transparent for a blue light with $\lambda = 436.6$ nm. Irradiation of the combined cells as described above for the cells with chalcogenide surfaces did not cause any twisted structures in the irradiated areas. This means that possible absorption of light with $\lambda = 436.6$ nm by LC molecules cannot be a cause of the photoalignment, at least on a glass surface. Second, we found that photoalignment is easily induced by polarized light with a wavelength that is not absorbed by a LC but rather is absorbed by a chalcogenide layer. The combined cell with the test chalcogenide layer $As_{20}Se_{80}$, and LC 5CB was irradiated with a polarized Gaussian laser beam ($\lambda = 532$ nm, $I_{\text{pump}} \approx 2.4 \times 10^5$ W/m^2, $\tau_{\text{exp}} = 30$ min) in the geometry described above. The chalcogenide glass $As_{20}Se_{80}$ absorbed 70% of light with $\lambda = 532$ nm and the LCs were totally transparent at this wavelength. The irradiation resulted in the twisted shown in Fig. 4.

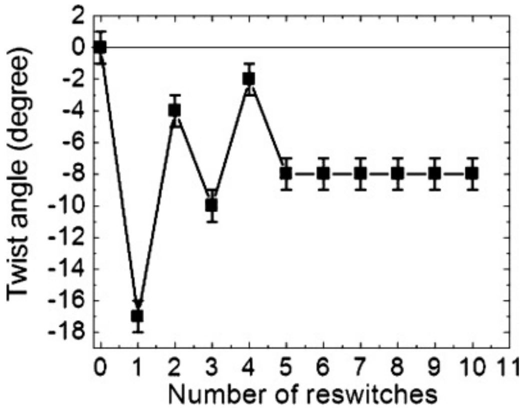

FIG. 3. Dependence of light-induced twist angle in cell filled with 5CB on a number of re-switches with alternating polarizations; $\phi = \pm\pi/4, \tau_{\text{exp}} = 30$ min.

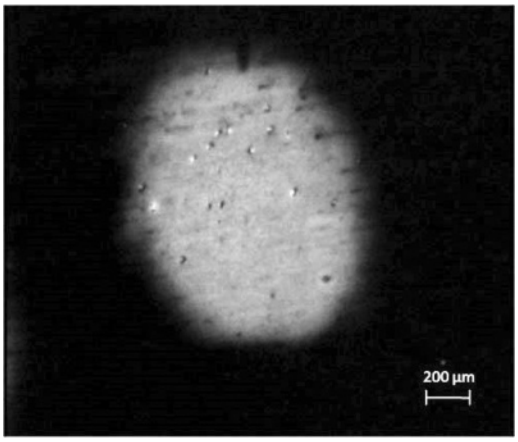

FIG. 4. Light-induced twist structure in the combined LC cell with test substrate$As_{20}Se_{80}$. Polarizers are crossed. Polarization of the input beam is parallel to direction of rubbing on the reference surface.

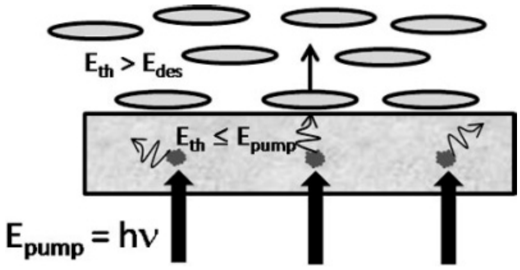

FIG. 5. Light-induced desorption of LC molecules from the chalcogenide surface after absorption of light in the chalcogenide layer.

These experiments allow us to conclude that the photoalignment is caused by absorption of light in the chalcogenide film. We propose the following model for the effect: It is well known that absorption of the polarized light by chalcogenide glass leads to a light-induced anisotropy of the chalcogenide layers [23]. The origins of this effect are still under discussion; in early publications, the photoinduced anisotropy in chalcogenide films was explained by interaction of polarized light with some optically anisotropic structural elements whose optical axes are oriented randomly [24,25]. Later, more detailed models were proposed that are based on consideration of the formation, ordering, and rearrangement of different kinds of dichroic anisotropic defects and main covalent bonds by linearly polarized light [26–31]. This anisotropy causes photoalignment of the LC parallel to the light polarization $\vec{E}_{\mathrm{UV}}$ when the chalcogenide is irradiated prior to filling the cell [19]. It should also work for the case of the irradiation of the filled cell. In our experiments this mechanism is revealed with short exposures and results in the positive light-induced twist (Fig. 2, $\tau_{\mathrm{exp}} \leqslant 2$ min).

We suggest that the photoalignment with $\phi_o < 0$ at longer exposures occurs due to the light-induced desorption of LC molecules from the chalcogenide surface after absorption of light in the chalcogenide (Fig. 5). The energy of the absorbed light by the dichroic anisotropic bonds of the glass E_{pump} is transferred to the neighboring adsorbed LC molecules. In our case the energy of the photon $E_{\mathrm{pump}} = h\upsilon = 2.8h\nu$ eV ($\lambda = 436.6$ nm) is larger than typical desorption activation energy of LC molecules $E_{\mathrm{des}} \approx 0.5$ eV [31] and the transferred energy E_{th} can result in desorption of LC molecules from the chalcogenide surface. The absorption of light by the covalent bonds is polarization sensitive and the efficiency of the energy transfer between the covalent bonds and LC molecules depends on the angle between their axes. Therefore, the light-induced desorption of LC molecule is also sensitive to the light polarization and results in an anisotropic angular distribution of the adsorbed LC molecules and formation of an easy orientation axis. The competition between this mechanism and the mechanism related to the light-induced anisotropy in chalcogenide determine the final alignment of the LC on the chalcogenide surface.

To make this mechanism more concrete we modeled the change of the angular distribution function of the adsorbed LC molecules on the chalcogenide glass. Since we found experimentally that the initial alignment of the LC in the cell is given by the reference substrate, we assumed that the angular distribution of the adsorbed LC molecules is determined mostly by the average azimuthal orientation of the LC in the bulk. In this case, the distribution function $g(\phi,\varphi(t))$ of the adsorbed LC molecules is the projection of the bulk LC molecules' distribution onto the surface [32,33]. This can be written as

$$g_{\mathrm{bulk}}(\phi,\varphi(t)) = \frac{1}{Z}\int_0^{\pi} \exp\left[\frac{3}{2}\beta S \sin^2\psi \cos^2(\phi-\varphi)\sin\psi\, d\psi\right], \tag{1}$$

where ψ is a polar angle, ϕ is the azimuth angle of LC molecules' long axes with respect to the rubbing direction on the reference surface, φ is the alignment of the director of LC (which is supposed to be in the azimuthal plane), $\beta = 4.55$, S is the LC bulk scalar order parameter, and the partition function Z is a normalization constant. In our model the initial distribution function of the adsorbed molecules $g_{\mathrm{ads}}(\phi,0) = g_{\mathrm{bulk}}(\phi,\varphi(0))$ after filling of the cell is maximum, which sets the direction of the easy orientation axis parallel to the director of the LC on the reference surface.

We suppose that the main mechanism of the light-induced anisotropy on the chalcogenide surface is related to phototransformation of the dichroic anisotropic defects that lead to their anisotropic angular distribution. This results in the rearrangement of the orientation of the adsorbed LC molecules to the axis of the angular distribution function of the anisotropic defects. In this model the dependence of angular distribution of the adsorbed LC molecules $g_{\mathrm{ads}}(\varphi,t)$ on the irradiation time t is

$$g_{\mathrm{ads}}(\phi,t) = \alpha(t)f(\phi) + h(\phi,t)[1-\alpha(t)]. \tag{2}$$

Here $\alpha(t)$ and $f(\phi)$ are the fraction and the angular distribution function of adsorbed LC molecules affected by the phototransformed defects and $h(\phi,t)$ is the distribution function of adsorbed molecules not affected by the anisotropic defects. In the initial state $h(\phi,0) = g_{\mathrm{ads}}(\phi,0)$.

In the case of a limited number of adsorbed LC molecules affected by the rearranged anisotropic defects,

$$\alpha(t) = \alpha_0(1 - e^{-kIt}), \tag{3}$$

where α_0 is total surface fraction of the adsorbed LC molecules affected by the phototransformed anisotropic defects, k is a coefficient that characterizes the decrease of α on irradiation of the chalcogenide surface, $k = \xi\sigma$, σ is the absorption cross section of dichroic the anisotropic defects, and ξ is the proportionality coefficient. The distribution function $f(\phi)$ can be chosen as

$$f(\phi) = \frac{1}{\pi}\cos^2(\phi-\theta), \tag{4}$$

where θ sets the axis of the angular distribution function of the oriented anisotropic bonds, which coincides with the polarization of light; in our experiment $\theta = \pi/4$. According to (2)–(4) the appearance of light-induced anisotropy on the chalcogenide surface in the filled cell results in a rotation of the angular distribution function of the adsorbed molecules and a drift of the initial easy orientation axis towards the direction given by the angle θ. This, in turn, leads to the formation of the positive twisted structure in the cell.

As mentioned above, in addition to the described mechanism we suggest desorption of LC molecules due to energy transfer from the dichroic covalent bonds after the light is absorbed. We assume that the angular dependence of the energy transfer to the adsorbed LC molecules is the same as in (4), that is, the most effective energy transfer occurs when the long axis of LC molecule and covalent bond are parallel. In this case the fraction of desorbed LC molecules with orientation angle ϕ induced by irradiation exposure t is

$$N_{\mathrm{des}}(\phi,t) = -\omega I t[1-\alpha(t)]h(\phi,t)f(\phi), \tag{5}$$

where $\omega = \eta\sigma$ is the coefficient of the light-induced desorption, η is the proportionality coefficient that includes the probability of energy transfer from the dichroic covalent bond to an adsorbed LC molecule and the probability of the following desorption of this LC molecule.

Due to light-induced desorption of the LC molecules, the evolution of the distribution function $h(\phi,t)$ is

$$\frac{dh(\phi,t)}{dt} = \omega I[1-\alpha(t)]\left[g_{\mathrm{bulk}}(\phi,\varphi(t))\int h(\phi',t)f(\phi')d\phi' - \right.$$
$$\left. - h(\phi,t)f(\phi)\right]. \tag{6}$$

Here we assume that after photodesorption of the LC molecules the free adsorption sites are immediately occupied by a LC molecule from the bulk, and the orientation of the new adsorbed molecules is preferably parallel to $\vec{n}$. In (6) we also neglect the possible spontaneous desorption of the LC molecules. The basis for this assumption is the stability of the light-induced twist structures in the experiments.

Equations (5) and (6) describe the dynamics of desorption of the adsorbed LC molecules, preferably along $\vec{E}_{\mathrm{pump}}$, and adsorption of LC molecules from the bulk along $\vec{n}$. These processes result in rotation of the angular distribution function of the adsorbed molecules and the drift of the easy orientation axis away from the direction defined by the angle θ. This leads to the formation of the negative twisted structure in the cell.

The final orientation of the director and the sign of the twist structure after irradiation of the filled cell is determined by the competition between the photoalignment due to the light-induced anisotropy in the chalcogenide layer and the photoalignment due to the light-induced desorption of the LC molecules. To determine the final orientation of the director on the chalcogenide surface we need to know the relationship between the angular distribution function, easy orientation axis, and anchoring energy of a LC. This relationship was studied in detail in Refs. [15] and [25]. In these publications it was shown that the surface potential that describes the interaction of the adsorbed layer of LC molecules with the director of the LC near the surface is

$$W_s(\varphi) = \tfrac{1}{2}W_0\cos 2(\gamma-\varphi). \tag{7}$$

Here W_0 is surface anchoring energy coefficient that depends on the adsorbed molecules distribution, φ defines the director orientation, and γ defines the easy orientation axis, which is determined by the averaged integral orientation of adsorbed LC molecules. In our case

$$\gamma(t) = \frac{1}{2}\mathrm{asin}\left\{\frac{S(t)}{\sqrt{C(t)^2+S(t)^2}}\right\}, \tag{8}$$

where

$$C(t) = \int_{-\pi/2}^{\pi/2} g_{\mathrm{ads}}(\phi,t)\cos 2\phi\, d\phi \text{ and}$$
$$S(t) = \int_{-\pi/2}^{\pi/2} g_{\mathrm{ads}}(\phi,t)\sin 2\phi\, d\phi, \tag{9}$$

We assume that the anchoring energy W_0 is so strong that the anchoring parameter $\xi = W_0 d/K \gg 1$, where K is a Frank constant of the LC. In this case the LC director is oriented along the easy axis on the chalcogenide surface, that is, $\varphi = \gamma$, and coincides with the twist angle measured in the experiments.

The numerical calculation of expression (8) for the light-induced twist angle φ with the parameters $\alpha^0 = 0.2$, $k = 1.4 \times 10^{-3}$ m^2/J, and $\omega = 0.7 \times 10^{-4}$ m^2/J is presented in Fig. 2 together with the experimental dependence $\varphi(\tau_{\mathrm{exp}})$. The numerical values of the fitting parameters are reasonable. The value $\alpha^0 = 0.2$ means that only a fraction (about 20%) of the adsorbed LC molecules can be aligned due to light-induced anisotropy of the chalcogenide surface. The coefficient k characterizes the increase of the anisotropy on the chalcogenide surface with the exposure dose. The same coefficient describes the dependence of the anchoring energy of the LC on photoaligning polymer surface with the light-induced anisotropy on the exposure dose. Recent measurements of this dependence for LC 5CB and the polymer fluorinated polyvinyl-cinnamate (PVCN-F) gave the value $k = 1.2 \times 10^{-3}$ m^2/J [34], which is very close to the value obtained in our experiments. The value obtained for the coefficient ω is of the same order of magnitude as the analog coefficient of photoinduced desorption of dye molecules from a photoaligning surface of the polymer PVCN-F [35].

The observed partial reversibility of the photoalignment (see Fig. 3) is also qualitatively explained within the frame of our model. The first mechanism of the photoalignment in our experiments is related to light-induced anisotropy in the chalcogenide film. This mechanism is irreversible since it is caused by structurally irreversible light-induced processes in the film. These processes result in the depletion of the phototransforming defects in the film and the disappearance of the photoalignment with the number of irradiation cycles having perpendicular polarizations. The second mechanism is determined by the energy transfer of the absorbing covalent bonds of the chalcogenide film to the LC molecules. Evidently, this process is at least partially reversible and determines the steady (not zero) value of the photoinduced twist angle that is achieved after several irradiation cycles with perpendicular light polarization, as depicted in Fig. 3.

It should be noted that our model takes into account neither light-induced changes of the anchoring energy W_0 during irradiation nor the change of the twist angle that is associated only with the gradual drift (gliding) of the easy axis on the chalcogenide surface. This assumption looks reasonable, as we observed initial strong magnetically-induced anchoring of the LC 5CB (see the experimental part).

Thus, the proposed model well describes the characteristics of the photoalignment of 5CB on chalcogenide glass As_2S_3. According to this model, the photoalignment strongly depends on the used LC because both adsorption and desorption of the LC molecules and efficiency of the energy transfer from absorbing units strongly depend on the molecular structure of the LC. It explains different characteristics of the photoalignment of the LCs 5CB and E44.

IV. CONCLUSIONS

Our studies show that the photoalignment of LCs on chalcogenide surface after irradiation of the filled cell is caused by two mechanisms. We associate the first mechanism with a light-induced anisotropy in chalcogenide layer, which leads to the anisotropic distribution of the LC molecules on the chalcogenide surface. This mechanism works both for the irradiation of the filled cell and for the irradiation of the chalcogenide substrate prior to the cell filling. The second mechanism is attributed to an energy transfer from the chalcogenide glass to the LC molecules adsorbed on the chalcogenide surface after light absorption, followed by desorption of the LC molecules from the chalcogenide surface. The competition between these mechanisms leads to the observed change of the easy axis orientation during exposure. The proposed model well describes the experimental data for the photoalignment of the LC 5CB on a chalcogenide surface As_2S_3. The model suggests strong a dependence of the photoalignment characteristics on the type of LC that corresponds to the experimental results.

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