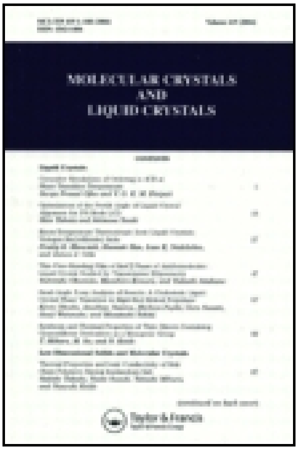

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On a Simple Way for Obtaining Important Material Constants of a Nematic Liquid Crystal: Longitudinal Flexoelectric Domains Under the Joint Action of DC and AC Voltages

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The threshold characteristics $U_c(U_{ac}), q_c(U_{ac})$ and $q_c(U_c)$, where U_c is the d.c. threshold voltage, U_{ac} is a high-frequency orienting voltage with a frequency above 5000 Hz, and q_c is the threshold wave number of the flexoelectric domains of Vistin'-Pikin-Bobylev, excited under the joint action of a d.c. voltage and a high-frequency orienting voltage, have been theoretically calculated for the case of anisotropic elasticity. These domains have been experimentally obtained in the nematic liquid crystal p-n-butyl-p-methoxyazoxy-benzene (BMAOB). The fitting of the experimental points by the theoretical curves permitted to obtain precisely the elastic constants of splay K_{11} and twist K_{22}, and the modulus of the difference between the flexoelectric coefficients of splay e_{1z} and bend e_{3x}, $|e_{1z} - e_{3x}|$, for a $\Delta\varepsilon$, varying between –0.20 and –0.25.

Keywords: determination; flexoelectric domains; material constants

INTRODUCTION

Longitudinal static domains with d.c. voltage-varying period have been observed for the first time by Vistin' [1,2] and independently by Greubel and Wolff [3]. Bobylev and Pikin [4] have clarified the flexoelectric nature of these domains developing a theory for the case of

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isotropic elasticity. They obtained simple relations for the threshold voltage U_c and the wave number q_c connecting the value of the electric field E with some of the material parameters of the nematic such as the dielectric anisotropy $\Delta\varepsilon$, the mean elastic constant K and the modulus of the difference between the flexoelectric coefficients (originally introduced for the first time by Meyer [5]) of splay e_{1z} and bend $e_{3x}, |e_{1z} - e_{3x}|$, as well as the thickness d of the liquid crystal layer. These important theoretical results stimulated further experimental study of these domains. Barnik *et al*. [6,7] have performed a very precise experiment, studying the flexoelectric domains very carefully. They showed first, that the flexoelectric domains appear only under the influence of a d.c. voltage or a voltage with infra-low frequency; second, that there is a cut-off thickness of the liquid crystal layer (20 μm) above which the domains disappear; third, that the electrical history of the samples is very important, etc. Now it is well known that these flexoelectric domains appear only in relatively pure nematics with a low specific conductivity, which should be in the range of 10^{-13} to 10^{-11} $(\Omega\text{cm})^{-1}$. Further, the contamination of the liquid crystal with ions or the development of electrochemical effects can remove the flexoelectric domains replacing them by electro-hydrodynamic domains of Williams or by injection domains [8].

In this paper, we elaborate some recently obtained theoretical and experimental results for the behavior of the flexoelectric domains in the presence of the joint action of d.c. and a.c. voltages [9]. We have elaborated also the theoretical results obtained by Bobylev, Chigrinov and Pikin [10] for the case of the anisotropic elasticity. Our results are based on some earlier theoretical results of Romanov and Sklyarenko concerning the influence of the flexoelectric phenomena on the thermal fluctuations of the nematic [11] and the behavior of the flexoelectric domains in a homeotropic nematic layer [12] (the detailed theoretical calculations performed by us will be presented separately). We have obtained formulae similar to those already obtained by Bobylev and Pikin [4,10], including also additionally applied high-frequency electric field , which orients the liquid crystal. In this way, we have obtained the following important threshold characteristics: $U_c(U_{ac}), q_c(U_{ac})$ and $q_c(U_c)$, where U_c is the d.c. threshold voltage, U_{ac} is a high-frequency orienting voltage with a frequency above 5000 Hz, and q_c is the threshold wave number of the flexoelectric domains of Vistin'-Pikin-Bobylev. Furthermore, theoretical curves have been calculated by computer and compared with the experimental results. In this way, we have obtained numerically four parameters, containing the material constants of the liquid crystal: the modulus of the dielectric anisotropy, the ratio of the two elastic constants of splay and twist, the elastic constant of splay, the elastic constant of twist, and the modulus of the difference between the flexoelectric coefficients of splay and bend. Since the system of four equations is over-determined, we should choose one material parameter as a running parameter. In our opinion, the dielectric anisotropy is the most appropriate material parameter for this goal and we chose it as a running parameter. In this way, we have obtained the real values of the other three parameters: the elastic coefficients of splay K_{11} and twist K_{22}, and the flexoelectric coefficient $|e_{1z} - e_{3x}|$, which were extracted from the experimental results.

THEORY

The "electric enthalpy" H_E of the nematic liquid crystal consists of three parts: elastic, flexoelectric and dielectric one [5,13]. In vector form it has the following form:

$$H_E = \int_V \left\{ \frac{1}{2} \left(K_{11}(\mathrm{div}\,\mathbf{n})^2 + K_{22}(\mathbf{n}\cdot\mathbf{rot}\,\mathbf{n})^2 + K_{33}(\mathbf{n}\times\mathbf{rot}\,\mathbf{n})^2 \right) - e_{1z}\mathbf{E}\cdot\mathbf{n}\,\mathrm{div}\,\mathbf{n} - e_{3x}\mathbf{E}\cdot(\mathbf{rot}\,\mathbf{n}\times\mathbf{n}) - \frac{|\Delta\varepsilon|}{8\pi}\left((\mathbf{n}\times\mathbf{E})^2 + (\mathbf{n}\times\mathbf{E_{ac}})^2 \right) dV \right\} \quad (1)$$

where the unit vector $\mathbf{n}$ is the nematic director, K_{11}, K_{22}, and K_{33} are the elastic constants of splay, twist and bend, e_{1z} and e_{3x} are the flexoelectric coefficients of splay and bend, $\Delta\varepsilon$ is the dielectric anisotropy (in our case negative), the vector $\mathbf{E}$ is the d.c. electric field and the vector $\mathbf{E_{ac}}$ is the orienting high-frequency electric field. Introducing the following components of $\mathbf{n}$, $\mathbf{E}$, and $\mathbf{E_{ac}}$: $n_x = \cos\theta\cos\varphi$, $n_y = \cos\theta\sin\varphi$, $n_z = \sin\theta$, $E_z = E$ and $E_{acz} = E_{ac}$ and accepting that for the case of longitudinal flexoelectric domains $n_x = 1$, finally we have expressed the "electric enthalpy" by the director components n_y and n_z and their derivatives with respect to y and z as follows:

$$H_E = \iint \left\{ \frac{1}{2} \left(K_{11} \left(\frac{\partial n_y}{\partial y} + \frac{\partial n_z}{\partial z} \right)^2 + K_{22} \left(\frac{\partial n_z}{\partial y} - \frac{\partial n_y}{\partial z} \right)^2 \right) - e_{1z} E n_z \left(\frac{\partial n_y}{\partial y} + \frac{\partial n_z}{\partial z} \right) - e_{3x} E n_y \left(\frac{\partial n_z}{\partial y} - \frac{\partial n_y}{\partial z} \right) + \frac{|\Delta\varepsilon|}{8\pi} n_z^2 (E^2 + E_{ac}^2) \right\} dy dz \quad (2)$$

The expression (2) shows that only splay and twist deformations enter the elastic energy [10]. Following the procedure of solution given in details by Romanov and Sklyarenko [11,12] we have obtained for the first time the exact solution of the problem under consideration. This claim is valid also for the conventional case when the high-frequency orienting electric field E_{ac} is absent. The minimization of the "electric enthalpy" given by Eq. (2) yields a solution which has the following form:

$$\begin{aligned} n_y &= f_1(\mathrm{z}) \sin qy \\ n_z &= f_2(\mathrm{z}) \cos qy \end{aligned} \tag{3}$$

(the periodic deformations along y were suggested by Bobylev and Pikin [4]), where

$$\begin{aligned} f_1(z) = \sqrt{\frac{K_{22}}{K_{11}}}\{ &[(w-p)(A_1e^{Qz}+A_2e^{-Qz})+(w+p)(B_1e^{Pz}+B_2e^{-Pz})] \\ &\times \cos\alpha + u\sin\alpha[A_1e^{Qz}+A_2e^{-Qz}+B_1e^{Pz}+B_2e^{-Pz}]\} \end{aligned} \tag{4a}$$

$$\begin{aligned} f_2(z) = &[(w-p)(A_1e^{Qz}+A_2e^{-Qz})+(w+p)(B_1e^{Pz}+B_2e^{-Pz})]\sin\alpha \\ &- u\cos\alpha[A_1e^{Qz}+A_2e^{-Qz}+B_1e^{Pz}+B_2e^{-Pz}] \end{aligned} \tag{4b}$$

$$a = \left(\frac{1}{2}+\frac{3}{4}\frac{K_{22}}{K_{11}}-\frac{1}{4}\frac{K_{11}}{K_{22}}\right)q^2+\frac{|\Delta\varepsilon|}{4\pi K_{11}}\left(E^2+E_{ac}^2\right),$$

$$b = \left(\frac{1}{2}+\frac{3}{4}\frac{K_{11}}{K_{22}}-\frac{1}{4}\frac{K_{22}}{K_{11}}\right)q^2$$

$$f = \frac{(e_{1z}-e_{3x})}{\sqrt{K_{11}K_{22}}}Eq, \quad \alpha = \frac{1}{2}\frac{(K_{11}-K_{22})}{\sqrt{K_{11}K_{22}}}qz, \quad p = \sqrt{\left(\frac{a-b}{2}\right)^2+f^2}$$

$$w = -a\sin^2\alpha - b\cos^2\alpha - f\sin 2\alpha + \frac{a+b}{2}, \quad u = \frac{a-b}{2}\sin 2\alpha + f\cos 2\alpha$$

$$P = \sqrt{\frac{a+b}{2}+\sqrt{\frac{(a-b)^2}{4}+f^2}}, \quad Q = \sqrt{\frac{a+b}{2}-\sqrt{\frac{(a-b)^2}{4}+f^2}} \tag{4c}$$

We have designated the integration constants by A_1, A_2, B_1 and B_2. These can be determined from the boundary conditions. The other quantities in Eq. (4c) are connected with the material parameters of the nematic liquid crystal and the values of the externally applied a.c. and d.c. electric fields. Additionally, in the solution take part the thickness d of the nematic layer and the threshold wave number q_c of the flexoelectric domains. Furthermore, we have accepted that the liquid crystal is strongly anchored on both glass plates confining the liquid crystal. Consequently, the following boundary conditions hold:

$$f_1\left(\pm\frac{d}{2}\right) = f_2\left(\pm\frac{d}{2}\right) = 0 \tag{5}$$

where $\pm(d/2)$ mean the upper (+) and the lower (–) boundary of the liquid crystal layer. Following the procedure given by Romanov and Sklyarenko [12] we have obtained the following threshold condition for the case of strong anchoring of a planar nematic layer and simultaneously applied along z a.c. and d.c. electric fields:

$$tg(iQd) = 0, \quad \pm iQd = \pi \tag{6}$$

Finally, following the procedure originally given by Bobylev and Pikin [4], we obtained a connection between the value of the constant electric field E and the value of the wave number q (see also the theoretical results obtained in Ref. [12]):

$$\begin{aligned} &E^2\left\{\frac{(e_{1z}-e_{3x})^2}{K_{11}K_{22}}q^2 - \frac{|\Delta\varepsilon|}{4\pi K_{11}}\left[\left(\frac{1}{2}+\frac{3}{4}\frac{K_{11}}{K_{22}}-\frac{1}{4}\frac{K_{22}}{K_{11}}\right)q^2+\left(\frac{\pi}{d}\right)^2\right]\right\} \\ &\quad = \left[\left(\frac{\pi}{d}\right)^2+\left(\frac{1}{2}+\frac{3}{4}\frac{K_{11}}{K_{22}}-\frac{1}{4}\frac{K_{22}}{K_{11}}\right)q^2\right] \\ &\qquad \times\left[\left(\frac{\pi}{d}\right)^2+\left(\frac{1}{2}+\frac{3}{4}\frac{K_{22}}{K_{11}}-\frac{1}{4}\frac{K_{11}}{K_{22}}\right)q^2+\frac{|\Delta\varepsilon|}{4\pi K_{11}}E_{ac}^2\right] \end{aligned} \tag{7}$$

The minimization of the function $E(q)$ leads to the following very important expressions for the threshold d.c. voltage U_c and the threshold wave number q_c as follows:

$$\begin{aligned} U_c^2 = &\frac{\pi^2 K_{11}K_{22}}{(e_{1z}-e_{3x})^2} \\ &\times\frac{\left[1+b_1\left(\frac{\mu}{1-b_1\mu}+\frac{1}{1-b_1\mu}P_{SQR}\right)\right]\left[1+a_1\left(\frac{\mu}{1-b_1\mu}+\frac{1}{1-b_1\mu}P_{SQR}\right)+\left(\frac{U_{ac}}{U_0}\right)^2\right]}{P_{SQR}}, \end{aligned}$$

$$P_{SQR} = \sqrt{\frac{(1-b_1\mu)\left(1+\left(\frac{U_{ac}}{U_0}\right)^2\right)+a_1\mu}{a_1 b_1}} \tag{8}$$

$$q_c^2=\left(\frac{\pi}{d}\right)^2\left(\frac{\mu}{1-b_1\mu}+\frac{1}{1-b_1\mu}P_{SQR}\right),\quad \mu=(|\Delta\varepsilon|K_{22})/4\pi(e_{1z}-e_{3x})^2 \tag{9}$$

$$a_1=\frac{1}{2}+\frac{3K_{22}}{4K_{11}}-\frac{1K_{11}}{4K_{22}},\quad b_1=\frac{1}{2}+\frac{3K_{11}}{4K_{22}}-\frac{1K_{22}}{4K_{11}},\quad U_0=\pi\sqrt{\frac{4\pi K_{11}}{|\Delta\varepsilon|}} \tag{10}$$

It is evident that the following inequality:

$$q_c^2>\mu\left(\frac{\pi}{d}\right)^2\frac{1}{1-b_1\mu} \tag{11}$$

has to be obeyed. It is possible from the expressions (8) and (9) to exclude the high frequency voltage U_{ac}. In this way we have obtained a simple relation between U_c and q_c:

$$U_c=\frac{\pi K_{11}}{|e_{1z}-e_{3x}|}\left(1+b_1\left(\frac{d}{\pi}\right)^2q_c^2\right)\sqrt{\frac{K_{22}}{K_{11}}a_1} \tag{12}$$

However, it is necessary to point out that this relation is valid for every value of the high frequency voltage determined by Eqs. (8) and (9). In other words, U_c and q_c, themselves are determined by Eqs. (8) and (9). From Eq. (12) one can obtain a simple relation between q_c and U_c as follows:

$$q_c^2=\left(\pi\frac{K_{11}}{|e_{1z}-e_{3x}|}\sqrt{\frac{K_{22}}{K_{11}}a_1}b_1\left(\frac{d}{\pi}\right)^2\right)^{-1}\left(U_c-\pi\frac{K_{11}}{|e_{1z}-e_{3x}|}\sqrt{\frac{K_{22}}{K_{11}}a_1}\right) \tag{13}$$

COMPARISON OF THE THEORETICAL AND EXPERIMENTAL RESULTS FOR THE CASE OF THE NEMATIC BMAOB AND DETERMINATION OF K_{11}, K_{22}, AND $|e_{1z}-e_{3x}|$

The knowledge of the material parameters of the liquid crystals such as elastic constants, viscosity, and flexoelectric coefficients etc. and their temperature dependence are of importance both for the scientific investigations and for the liquid crystal devices [14–16]. There are many well known methods for the measurements of the material parameters of the liquid crystals such as Freedericksz transition, thermal fluctuations, boundary effects, and in particular for the measurement of the elastic constants of the nematics [17]. In the last time one appears many methods for the simultaneous measurement of several material parameters at once [18–20]. We present here a novel method for the measurement of three from four material parameters of every nematic liquid crystal (the fourth parameter must be running and can be chosen depending on the circumstances). The four material parameters are as follows: $K_{11}, K_{22}, |e_{1z} - e_{3x}|$, and $\Delta\varepsilon$. Three of these material parameters can be determined with a high accuracy after comparison of the theoretical curve $U_c(U_{ac})$ given in the previous paragraph with the experimental points. The same material parameters and the thickness of the liquid crystal layer in the region of the cell with the flexoelectric domains can be determined also after comparison of the theoretical curves $q_c(U_{ac})$ and $q_c(U_c)$ (see the previous paragraph) with the experimental points. Since our method for the measurement of the material parameters is based on the flexoelectric behavior of the nematic under the joint action of a d.c. voltage and a high-frequency orienting voltages we chose the nematic BMAOB (p-n-butyl-p-methoxyazoxy-benzene) which show well developed flexoelectric domains under the application of a d.c. voltage. On the other hand, the dielectric anisotropy of this liquid crystal is known to vary between -0.22 [21] and -0.25 [6,7]. However, the measurements of the elastic constants and the flexoelectric coefficients are scarce [6,7,21,22] and in some cases controversial. BMAOB is a mixture of two isomers and is very similar to the liquid crystal produced by Merck under the name Merck IV or N4 [3,24,25,26]. The only difference is in the ratio of the two isomers: 60 versus 40 wt% (BMAOB) and the reverse (N4).

The electro-optical behavior of BMAOB was studied in a wedge-shaped cell consisting of two conductive ITO coated glass plates, rubbed with a diamond paste to ensure strong planar anchoring of the liquid crystal. We used only one Mylar spacer for this cell with a thickness of 25 μm. The cell was 50 mm long: the wedge angle was measured to be 0.026°. This small value indicates a negligible inhomogeneity of the electric field along the long side of the cell.

The presence of ions, resp. the inhomogeneity of the electric field influences strongly the behavior of the flexoelectric domains [27]. Derzhanski and Petrov have obtained exact formulas for the threshold voltage U_c and the wave vector q_c for the case of linearly varying along z electric field and for isotropic elasticity. Their theoretical results show the considerable influence of the inhomogeneity of the electric field on the threshold characteristics of the flexoelectric domains. The inhomogeneity of the electric field due to the presence of impurity ions or injected ions can be taken into account in Eq. (7) by inclusion of the additional term $((e_{1z} + e_{3x})/K_{11})(dE/dz)$. Further, the mathematical procedure should be performed in the same manner [9]. However, we should stress upon several difficulties: First, the function dE/dz is unknown and it is simpler to accept a linear variation of the electric field along z [27]. Evidently this is justified only for unipolar injection. One can use also hyperbolic or exponential variation of the electric field, etc. Second, it is evident that the function dE/dz changes itself with the increase of the d.c. voltage and will be different for the various experimental points. Third, the presence of injected ions from the one electrode or from the two electrodes can provoke the creation of injection domains [8] (we have really observed the simultaneous existence of the flexoelectric domains and the injection domains in one and the same places of the liquid crystal area). Fourth, the influence of the high-frequency electric field on the ions is unknown although it is able to remove the injection domains. It is clear that the reported experiment should be performed with fresh liquid crystal materials with a very low specific conductivity and in the absence of a pronounced injection. In effect, the good fitting procedure proves the homogeneity of the electric field in our case.

The cut-off frequency of the liquid crystal studied was measured to be around 70 Hz which corresponds to a specific conductivity of around $3 \times 10^{-11}\,(\Omega\mathrm{cm})^{-1}$. Due to the purity of our liquid crystal, injection phenomena and injection domains were avoided during the performance of our experiment [28,29].

The experiment is described in details elsewhere [9]. The experimental points for the d.c./a.c. case, together with the theoretical curves obtained according to Eq. (8) are shown in Figures 1 and 2. Initially we applied a d.c. voltage up to the appearance of the flexoelectric domains. Then we applied an a.c. voltage, keeping the d.c. voltage constant up to the disappearance of the domains. Next, keeping the same value of the a.c. voltage, we increased the d.c. voltage further, just to see re-appearance of the domains. This procedure was performed for all points shown in Figures 1 and 2. The computer calculations fitted the theoretical curves to the experimental points. It is seen from Figures 1 and 2 that the fitting is very good for the following values of the four parameters:

$$\mathrm{P}_1 = K_{11}/|e_{1z} - e_{3x}|, \quad \mathrm{P}_2 = K_{22}/K_{11}, \quad \mathrm{P}_3 = \mu = (|\Delta\varepsilon|K_{22})/4\pi(e_{1z} - e_{3x})^2,$$

$$\mathrm{P}_4 = U_0 = \pi\sqrt{\frac{4\pi K_{11}}{|\Delta\varepsilon|}} \tag{14}$$

as follows: $\mathrm{P}_1 = 0.0023$, $\mathrm{P}_2 = 0.8$, $\mathrm{P}_3 = 0.567$, $\mathrm{P}_4 = 6.5$.

As a running parameter we chose the dielectric anisotropy $\Delta\varepsilon$ of BMAOB since it is well known that it varies between –0.20 and –0.25. The other parameters: the elastic constant of splay K_{11}, the elastic constant of twist K_{22} and the modulus of the difference between

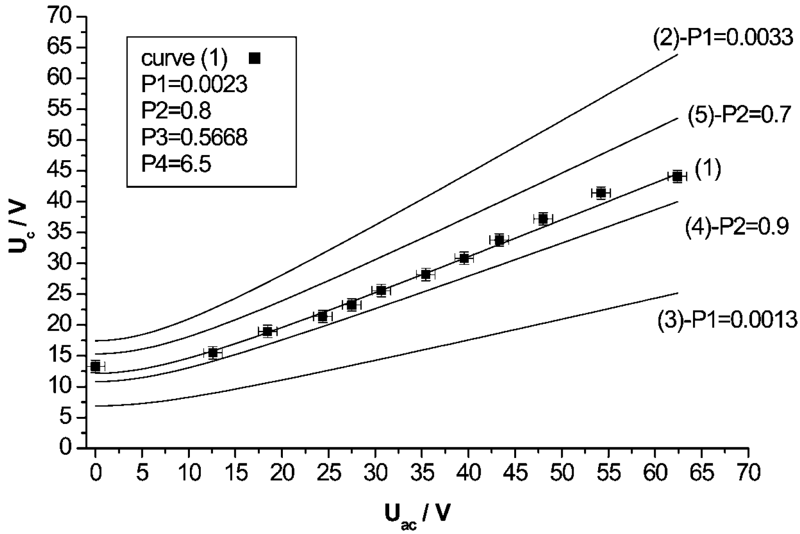

FIGURE 1 The threshold voltage U_c showing the appearance of the flexoelectric domains as a function of the a.c. voltage in a strongly-anchored nematic layer of BMAOB at room temperature: theoretical curves and experimental points at the fitting parameters (curve 1) and appropriate deviations of the parameters P_1 and P_2, where $P_1 = K_{11}/|e_{1z} - e_{3x}|$, $P_2 = K_{22}/K_{11}$.

the flexoelectric coefficient of splay e_{1z} and bend e_{3x} : $|e_{1z} - e_{3x}|$ are calculated according to the relations (14) and presented in Table 1. The sensitivity of the novel method is illustrated with all the other curves shown in Figures 1 and 2 and their deviation from the fitting curve (1). The experimental points are hardly expected to follow precisely the theoretical curve (1) due to experimental errors: the appearance of the flexoelectric domains is observed visually leading to some uncertainty in the determination of the threshold voltage. However, it is well known that the flexoelectric domains start with a finite value of the initial deformations (a first order phase transition) [4,30,31] and this fact facilitates the visual observation of the domains' onset. For completeness we have determined also the period of the flexoelectric domains. The comparison of the experimental points and the theoretical curves obtained according to Eqs. (9) and (13) is shown in Figures 3 and 4. This fit is not so good. That may be due firstly to the method used to count the domains directly under the microscope, secondly to local variations of q_c, and thirdly to the polarizers used (it is well known that the number of the domain lines depends crucially on the mutual position of the two polarizers and the orientation of the

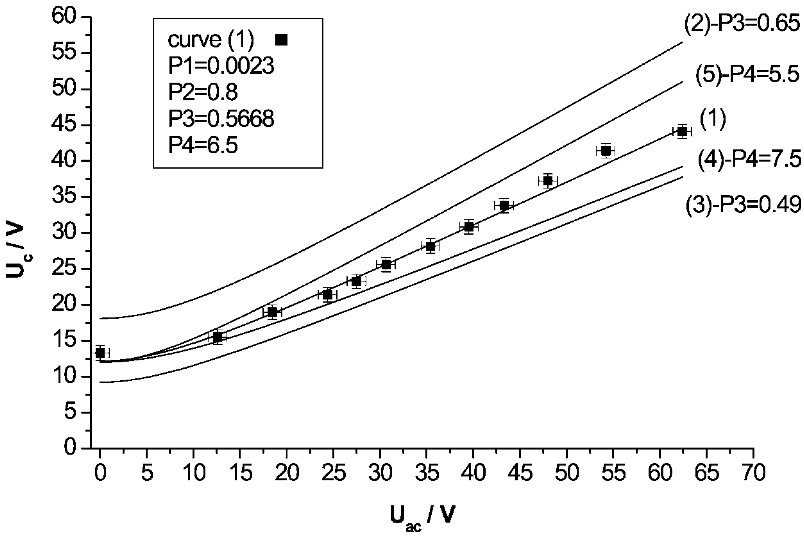

FIGURE 2 The threshold voltage U_c showing the appearance of the flexoelectric domains as a function of a.c. voltage in a strongly-anchored nematic layer of BMAOB at room temperature: theoretical curves and experimental points at the fitting parameters (curve 1) and appropriate deviations of the parameters P_3 and P_4, where $P_3 = \mu = (|\Delta\varepsilon| K_{22})/4\pi(e_{1z} - e_{3x})^2$, $P_4 = U_0 = \pi\sqrt{4\pi K_{11}/|\Delta\varepsilon|}$.

domains with respect to them [31]). In addition, let us also mention that the determination of the four parameters from these curves is quite sensitive to the thickness of the liquid crystal layer. In our opinion, the value of this thickness should be determined by other, more reliable methods such as the optical ones [32,33].

The ratio K_{22}/K_{11} was determined to be 0.8. Blinov measured the same ratio of these two elastic constants [21]. However, the values

TABLE 1 The Obtained Values for the Elastic Constants of Splay K_{11} and Twist K_{22}, and the Difference between the Flexoelectric Coefficients of Splay and Bend $|e_{1z} - e_{3x}|$ for Different Values of $\Delta\varepsilon$

$\lvert\Delta\varepsilon\rvert$	$\lvert(e_{1z} - e_{3x})\rvert$[dyne$^{1/2}$]	K_{11} [dyne]	K_{22} [dyne]
0.20	3.291×10^{-4}	0.757×10^{-6}	0.606×10^{-6}
0.21	3.461×10^{-4}	0.796×10^{-6}	0.637×10^{-6}
0.22	3.626×10^{-4}	0.834×10^{-6}	0.667×10^{-6}
0.23	3.791×10^{-4}	0.872×10^{-6}	0.698×10^{-6}
0.24	3.957×10^{-4}	0.910×10^{-6}	0.728×10^{-6}
0.25	4.122×10^{-4}	0.948×10^{-6}	0.758×10^{-6}

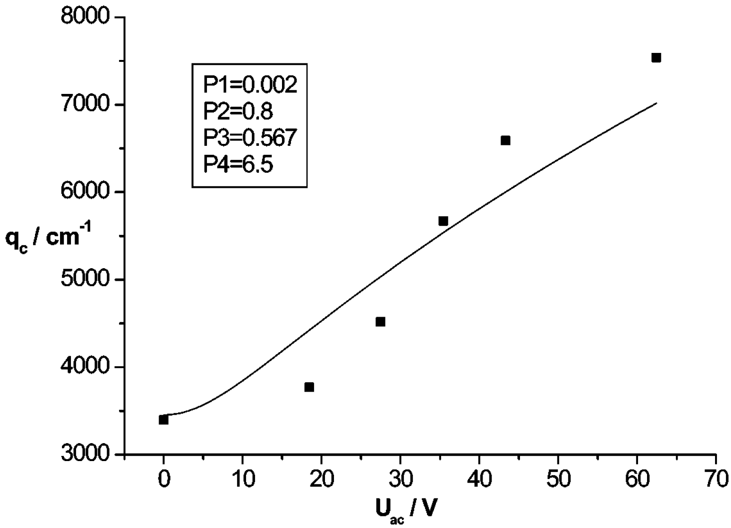

FIGURE 3 The wave number q_c of the flexoelectric domains as a function of the a.c. voltage U_{ac} in a strongly-anchored nematic layer of BMAOB at room temperature: the experimental points and the fitting curve.

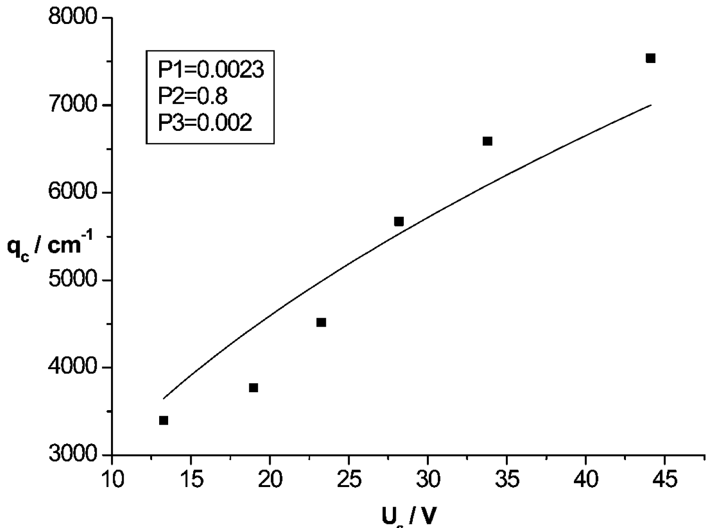

FIGURE 4 The wave number q_c of the flexoelectric domains as a function of a threshold d.c. voltage *Uc* in a strongly-anchored nematic layer of BMAOB at room temperature: the experimental points and the fitting curve.

of the elastic constants themselves measured in our experiment were slightly bigger. For $|e_{1z} - e_{3x}|$ we found that it is more than two times bigger (see Table 1) than that widely accepted [6,7]. Let us mention though, that our values are obtained after comparison of the experimental points with exact theoretical formulae rather than with the approximate ones before. The sign of the flexocoefficient $(e_{1z} - e_{3x})$ cannot be determined from these threshold characteristics. However, it enters the exact solution via u and f [see Eq. (4c)] and evidently one can determine it from the above-threshold behavior of the flexoelectric domains (see, for instance, the measurement performed by Tanguay *et al*. [31].

In summary, we have proposed a simple method for measurement of some important material constants of a nematic liquid crystal displaying longitudinal flexoelectric domains of Vistin'-Pikin-Bobylev. Comparing the theoretical and experimental results we have obtained that the flexocoefficient $|e_{1z} - e_{3x}|$ for the liquid crystal BMAOB is two times bigger at room temperature than previously accepted. It is clear that as a next step the temperature dependence of these material constants can be easily obtained in the range of the temperature where the flexoelectric domains exist.

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