INFLUENCE OF PRELIMINARY ARGON ION BOMBARDMENT OF SILICON AND GERMANIUM SUBSTRATES ON ORIENTATION OF LIQUID CRYSTALLINE MOLECULES

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The possibility of homogenous orientation of liquid crystalline (LC) molecules is studied after bombardment of substrates transparent in infra-red (IR) spectral region (Si, Ge) by argon ions and also after chemical etching. The control of orientation of LC molecules is made by the methods of IR spectroscopy and dielectric measurements..

It has been established that with increasing of ion fluence at preliminary bombardment of substrates by argon ions with energy of 250 eV the LC molecules are oriented planarly while at ion energy of 1.25 keV they are done planarly and then – homeotropically. The preliminary chemical etching of silicon substrates by the solution of KOH in the water and ethylenglycol promotes to planar orientation of LC molecules. The most effect of homeotropic orientation of LC molecules is obtained by preliminary argon ion bombardment of substrates with energy of 250 eV and subsequent etching in the solution of KOH and ethyleneglycol.

1. Introduction

In order to appreciable an electrooptical effect in liquid crystal (LC), it is absolutely necessary to bring the LC molecules into a certain orientation on the cell bordered walls. Then molecules of the subsequent layers will be arranged to molecules of the surface layer and all volume will represent a single crystal.

One of the methods to obtain a planar configuration of the nematic LC is the substrate rubbing [1-3]. After passing through a micro porous filter (pore diameter ~ 0.5 μm), the 3% water solution of the polyvinyl alcohol (PVA) is deposited onto a rotating substrate (400 rev/min) at room temperature. The deposited film is dried up for 30 minutes at 80°C, first, and, then, is rubbed using a piece of textile or the diamond paste.

Using rubbing, homogeneous orientation of LC molecules is obtained for any substrates. Instead of PVA, a solution of the polyamide in N-methylpirrolidane, diluted in the ratio 1:10 can be used. The polymerization is then achieved in two stages; by 30 minutes annealing at 130°C and 200°C.

The planar orientation of the LC molecules is also obtained by slanting deposition of the oxides onto relevant substrates.

One of the methods to obtain a hometropically oriented layer is to place a nematic liquid crystal (NLC) between the surfaces covered by lecithin. A solution of the natural egg lecithin in the volatile solvent (alcohol) is used for substrate coating. The concentration of the solution is about 1%. After the coating procedure the substrate is rinsed with solvent and dried up for 30 minutes at 80º C. Another method is to use polymethylsiloxane layer which is easily obtained from dimethyldichlorsilan (10 % solution in toluene) by immersing the plate for 15 minutes at room temperature. Then the covered surface is rinsed by isopropanol and annealing for 30 minutes at 100º C. In order to orientate the molecules of 4-methoxybenzylidene-4-butylaniline (MBBA) and 4-ethoxybenzylidene-4-butylaniline (EBBA) mixture, polymethylfenilsiloxane or the mixture of polymethyl and polydimethylsiloxane (10 % solution in toluene) are used. Plates are immersed in a solution for 15 minutes at room temperature. The coated surfaces are rinsed in isopropanol and annealed for 30 minutes at temperature 80-100º C LC molecules.

For homogeneous orientation of the LC molecules in some cases it is impossible to apply the above-stated methods. In particular, at manufacturing of photon crystals with the LC stuffing [4-5] it is impossible to apply the method of rubbing. And at using of the LC for special problems of modulation of infra-red light applying of surface-active substances [6] is undesirable. Therefore a search of alternative methods of processing of a surface is an actual problem. In particular, such methods are bombardment of a surface by ions and application of chemically active substances for deep etching.

At bombardment of a surface by ions of neutral gases, the atoms can take off from this surface. This process is called the dispersion. Erosion of a surface leads to structural change of surface layers because of dispersion and is characterized by the dispersion factor defined as an average of the atoms deleted from a solid surface by one particle. Dispersion factors depend on energy of ions, their mass, falling angle, mass of target atoms, crystallite of targets, orientation of crystal axes, and surface energy of bond of target material. Below some threshold energy which is equal to 20-40 eV at normal falling of ions, dispersion practically is absent [7]. Above a threshold the dispersion factor increases with increasing of energy of falling ions and reaches a wide maximum at the energy of 5-50 keV. At high energies the reduction of dispersion factor is connected with increasing of depth of penetration of primary ions in a target and reduction of a part of the energy passed to surface layers by them. Dispersion of a surface material by the accelerated ions of sufficient energy and fluence leads to formation of microscopic deepening which can be the centers of orientation for elongated LC molecules.

It is known that places of crossing of crystal surface by a dislocation are the easiest influence to various solvents. It is connected with that the atom bonds are deformed around of a dislocation line in the crystal: they are stretched in one places, ones are compressed or broken absolutely off in others. The area of a crystal has superficial surface energy around dislocations. This does it in places of an output of a dislocation on a surface by less steady to the influence of chemical etching. Etching poles, as a result of various rate of etching on a crystal surface, are formed in places of an output of dislocations which can also be the orientation centers for LC molecules.

In the work the possibility of homogenous orientation of LC molecules are studied after argon ion bombardment of substrates transparent in infra-red spectral region (Si, Ge) and also after a method of chemical etching.

2. Experimental

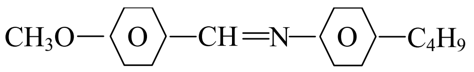
Plant was assembled on the base of the VU-1 vacuum device for bombardment of the various semiconductor and dielectric plate surfaces by argon ions (Fig.1). In the order to obtain the homeotropic orientation of LC molecules, high-purity p-type silicon and germanium plates transparent in the mid-IR region were bombarded by argon ions with the fluence defined by the exposition time.

The pairs of plates were fixed on the metal plain base and suspended above a high-voltage electrode on the distance of 40 mm from it. At that case irradiated plates were zero potential. High-purity argon was used as a working gas. A glow discharge was ignited in the chamber at the voltage supply on the electrode. Processing regime was following: ion energy of 250 eV, ion current density of 0.2 mA/cm^2, and pressure of working gas of 10 Pa. An ion fluence depended from exposition time. It was determined by expression $D = j\, t/e$, where j – ion current density, t – exposition time, e – ion charge. The fluency was $1.5 \cdot 10^{18}$ cm^{-2} at above-indicated conditions and the irradiation time of 20 min. The exposition time varied between 5 and 60 min.

Fig.1. Vacuum plant VU-1 with the system of ionic etching.

With the purpose of effective deepening formation in substrate surfaces, apart the source of Kaufman type was used for increasing of ion argon energy. In order to create the dense plasma, the discharge with the heated cathode was used in a longitudinal magnetic field. Owing to electron oscillations in transverse electromagnetic fields, the high uniformity of plasma was reached. The three-electrode system of ion extraction allows forming the beam with a diameter of 100 mm and homogenous current. Parameters of the source are following: cathode heating current-12 A; magnet coil current-up to 30 A; discharge current-up to 2 A; discharge voltage-up to 100 V; energy of ions-up to 2 keV; ion beam current-up to 30 mA; ion current density-up to 100 μA/cm^2. The ionic source is installed on the base of the VU-1 device with limiting vacuum of $5{\cdot}10^{-6}$ Torr.

The idea of the control of LC molecule orientation by the method of infra-red spectroscopy (IR) consists that at concurrence of an electric vector of incident light with the vibration of certain group along a long axis of the LC molecule the corresponding absorption band has maximal intensity. If the direction of an electric vector of incident radiation is perpendicular to one of vibrations along a long axis of a molecule, the corresponding band has the minimal intensity. At application of direct electric field above Fredericksz threshold to the LC cell with negative dielectric anisotropy all molecules are arranged along the cell plane and the corresponding band has the maximal value. Nematic LC 4-methoxybenzilidene - 4' - butylaniline (MBBA) is used for the control of molecule orientation. It has negative optical anisotropy and is described by the structural formula



Thus the group - CH=N- vibrates along a long axis of the MBBA molecules. According to [8] its frequency has value about of 1630 cm^{-1}.

IR absorption spectra were carried out on double-beam infra-red spectrophotometer IKS-29 and supervised by double-beam infra-red spectrophotometer Specord - 75 IR in the frequency region of 4200 - 400 cm^{-1} and 4000 - 400 cm^{-1}, accordingly. The resolution and an accuracy of definition of frequencies were not worse than 2 cm^{-1}.

The study of the LC molecule orientation is carried out in so-called "sandwich» cell consisting of two identically processed silicon or germanium parallel plates between which there is liquid crystal MBBA (Fig.2). Thus the processed surfaces of plates adjoin with LC.

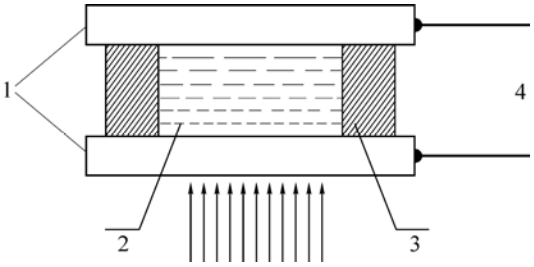


Fig.2. The cell for measurement of IR spectra. 1-silicon or germanium plates; 2-liquid crystal; 3-gaskets; 4- conductive wires.

It is necessary to note that high-purity silicon and germanium are rather transparent in mid-IR region and have only several weak two-phonon bands which are easily compensated in doable-beam spectrophotometer by accommodation of the same plate without LC in the reference window (Рис.3). Both materials equally reflect a lot of light - losses reach to 50 %.

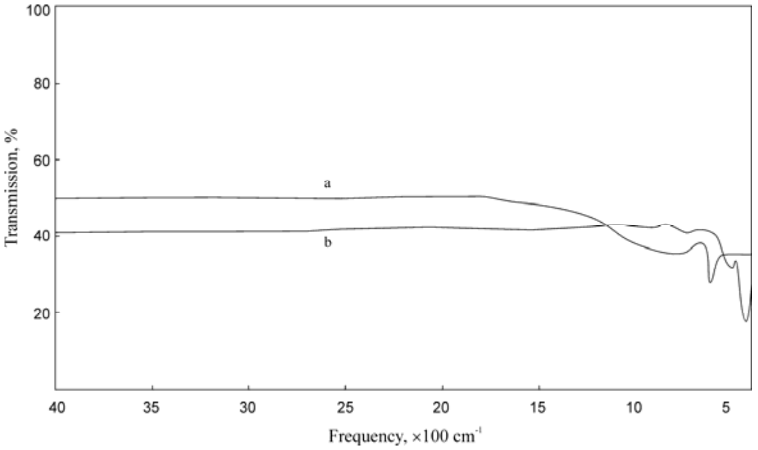


Fig.3. Transmission spectra of silicon (a) and germanium (b) plates with thicknesses of 320 μm and 980 μm, accordingly.

The thickness of LC layer in the cell is regulated by special dielectric gaskets and determined by measurement of capacity of empty cell by formula $d = \varepsilon_0 S/C$, where $\varepsilon_0 = 8.85$ nF/m electrical constant, *S*- the square of working part of electrooptical cell, *C* – electrical capacity of the cell. An accuracy of thickness definition is about 0.1 μm. Thickness uniformity is provided by spatial holder allowing to press glass plates to each other from four extreme points and to remove a wedge which is shown as interference bands. The cell is filled by capillary method in vacuum when LC has isotropic phase.

For definition of voltage at which there is Fredericksz' effect the capacity measurement of the same cell versus voltage is used.

Thus the capacity of the cell is changed depending on initial orientation of LC molecules, caused by change of dielectric permeability of LC in the direction perpendicular to the cell. The capacity measurement is carried out on low frequency (up to 1kHz), that creates the certain difficulties of measurements.

In order to measure the value of LC capacity change, the scheme of the differential amplifier with compensation was used. The signal from generator G of sine wave oscillations was applied to the LC cell *S* through element R3C2 having on measured frequency of 1 kHz much greater resistance than the cell. A signal on structure through dividing condenser C2 was applied on a high-resistance input of differential amplifier A1. On other input A1 for balance on input from generator G was applied an anaphase signal of the same value. Thus, the signal on output A1 was minimal at absence of voltage on the cell. Voltage on structure was applied from potentiometer R1 and supervised by voltmeter V. At changing of the cell capacity with change of the applied voltage on output A1 there is a signal which was registered on the oscilloscope Os. The value of the changed capacity was determined by the method of compensation of calibrated variable capacity C3 included in parallel with the structure. The structure was located in a warmed cavity *T* with the temperature regulator and the measuring device of temperature for carrying out of measurements in the temperature interval 15˚-45˚C.

3. Results and discussion

Study of influence of bombardment of silicon and germanium substrates for homogeneous orientation of LC molecules is carried out on the example of MBBA. IR spectra of MBBA at different thicknesses are shown on Fig.4. Apparently, a set of strong and weak absorption bands is observed in these spectra.

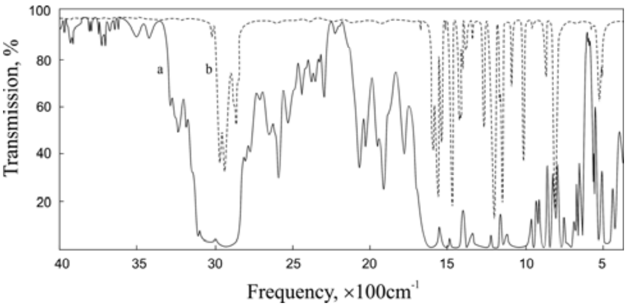


Fig.4. Transmission spectra of the cell with MBBA at different LC layers: a – 205 μm; b – 10 μm.

Each absorption band corresponds to vibration of the certain group of atoms. In particular, a set of bands between 3050cm^{-1} and 2850 cm^{-1} corresponds to vibrations of CH_2 and CH_3 groups. For the orientation control of elongated MBBA molecules we use a band with a maximum of 1630 cm^{-1} which corresponds to -CH=N- group vibrating along a long axis of the MBBA molecule. This band together nearby ones are represented on Fig.5.

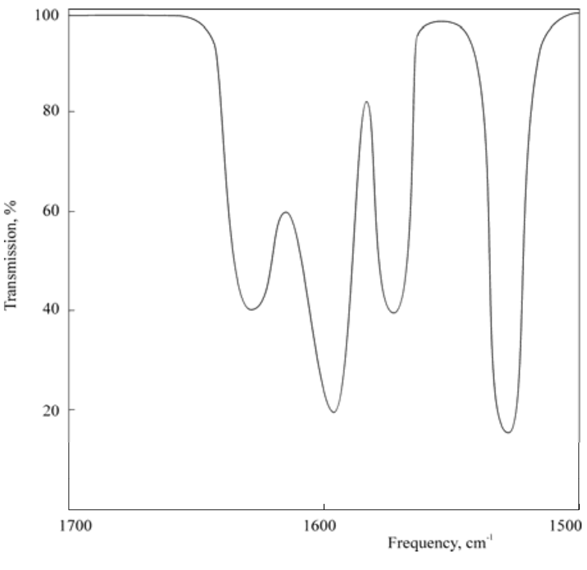


Fig.5. Transmission spectrum of the non processed silicon cell with MBBA with thickness of 10 μm near the band corresponding to vibration of the group -CH=N-.

The intensity of bands changes at increasing of the voltage applied to the cell. The band with a maximum of 1630 cm^{-1} gradually increases its intensity since the voltage of 3.5 V, reaching the maximal value at some voltage. It is obvious, that at this voltage all MBBA molecules settle down in parallel to relation of a substrate that corresponds to concurrence of the direction of vibration of the group -CH=N- with the direction of an electric field of incident radiation. The measurement of dependences of transmission from voltage on maxima of bands near the above-stated band is carried out for more correct definition of kinetic changes of the band intensity. Corresponding dependences are shown on Fig.6.

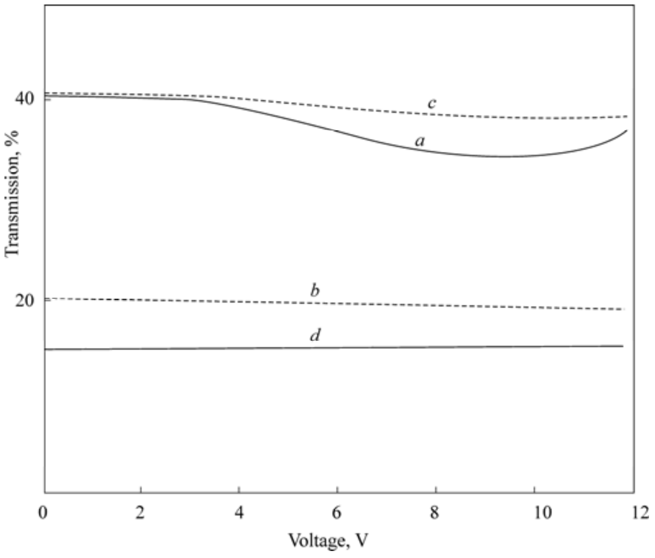


Fig.6. Light transmission of the non processed silicon cell with MBBA depending on the applied voltage at various frequencies: a - 1630 cm^{-1}; b - 1596 cm^{-1}; c - 1575 cm^{-1}; d - 1512 cm^{-1}.

As seem from this figure, the intensity of light passing through the cell on frequency of 1630 cm^{-1} gradually increases since 3,6 V, reaching the saturation at 7,5 V then it decreases while it does not almost vary on frequencies corresponding to maxima of other bands. It is interesting to note that the dependence of capacity from voltage similarly behaves (Fig.7).

It is obvious that the beginning of an increase in capacity and absorption on frequency of 1630 cm^{-1} corresponds to the beginning of reorientation of LC molecules. Saturation corresponds to full orientation of molecules in parallel to the substrate surface and reduction does to origin of turbulence (electrohydrodynamical instability) which is characteristic for liquid crystals with negative anisotropy of dielectric permeability.

If it is primary the LC is not oriented in the cell, the maximal change of capacity at application of voltage makes $C(U=7.5\ \text{V})/C(U=0) = \varepsilon_\perp / \langle \varepsilon \rangle = 1.125$, where the average value of dielectric permeability is equal to $\langle \varepsilon \rangle = 1/3(2\varepsilon_\perp + \varepsilon_{||})$; $\varepsilon_\perp$ и $\varepsilon_{||}$ are dielectric permeabilities for orientation of molecules perpendicularly and parallel to the substrate surface, accordingly.

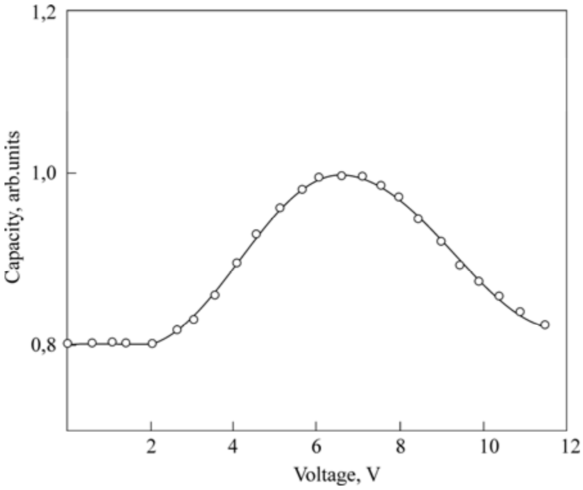


Fig.7. The dependence of capacity of the cell with the non processed silicon electrodes on voltage.

It is known that integrated absorption of a resonant band is proportional to the number of oscillations corresponding to the given optical transition. The dependence of integrated absorption from voltage on the band corresponding vibrations of group -CH=N- is shown for the non processed silicon substrates. It is obvious that the initial part of the graph up to 3.5 V corresponds to non orientated LC molecules while a part of saturation does to full their planar orientation.

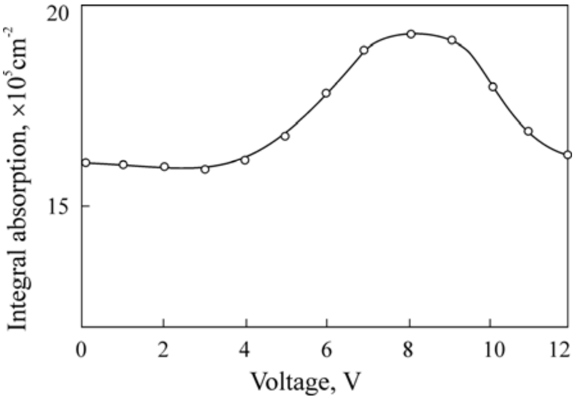


Fig.8. The dependence of integrated absorption from voltage on the band corresponding vibrations of the group-CH=N- at the non processed silicon substrates.

It is obvious that to judge about orientation of LC molecules after processing of substrates is possible on an initial part of the graph while the part of saturation coincides for all types of substrate surface processing. If after substrate processing the initial part of the graph is placed above the graph corresponding to the cell with the raw substrates then the molecules aspire to be situated planarly and if below then they do homeotropically. The value of deviation corresponds to a degree of this or that orientation of molecules.

The dependence of integrated absorption from irradiation doze is shown on Fig.11 at preliminary processing of silicon substrates by argon ions with energy of 250 eV.

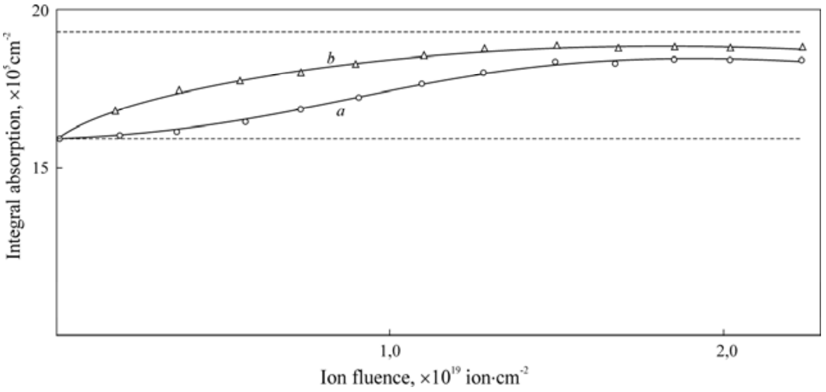


Fig.9. The dependence of integrated absorption from the ion fluence on the band corresponding vibrations of the group-CH=N- after processing of silicon (a) and germanium (b) substrates by argon ions with energy of 250 eV.

As seen from Fig. 9, the LC molecules aspire to be situated planarly at processing of substrates by argon ions with energy of 250 eV. A decrease of the value of capacity change without and with voltage application confirms initial orientation of LC molecules parallel to the substrate (Fig.10). At that case, the initial orientation of the LC molecules is arranged on the germanium substrates at less fluences than on the silicon ones. This fact is explained by more dispersed factors for germanium than for silicon.

At preliminary processing of substrates by argon ions with energy of 1.25 eV the LC molecules are arranged planarly at less fluences and more fluences – homeotropically. At that case, the LC molecules are arranged homeotropically at less fluences of germanium plates than silicon ones (Fig. 11).

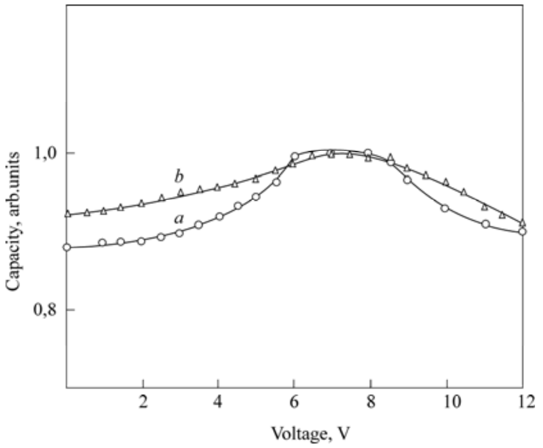


Fig.10. The dependence of the LC cell capacity with preliminary bombardment of silicon (a) and germanium (b) electrodes by argon ions with energy of 250 eV and an ion fluence of $7.5 \cdot 10^{18}$ ion $\cdot$cm^{-2}.

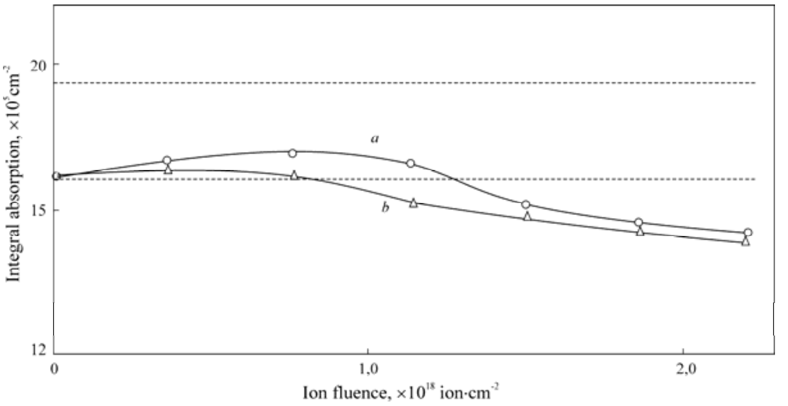
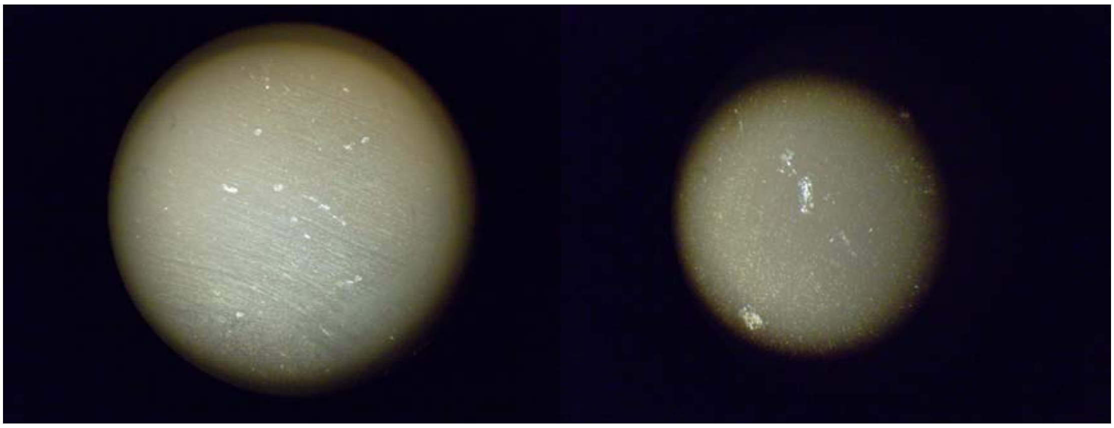


Fig.11. The dependence of integrated absorption on the band corresponding vibrations of the group-CH=N-from the irradiated doze after processing of silicon (a) and germanium (b) substrates by argon ions with energy of 1.25 keV.

At bombardment of crystals by ions of a different fluence there are two effects of opposite character. The smoothing of a surface originally possessing some roughness is occurred at ion fluences in the interval of 10^{16} cm^{-2} - 10^{17} cm^{-2} [9]. Enough plenty of radiation defects leading development of a relief on the surface is collected inside the crystal at fluences exceeding to 10^{17} cm^{-2}. Surface energy of bond can be decreased and the dispersion factor can be increased near the defects because of presence of mechanical pressure. Initial roughness can be increased at badly prepared surface. At this case, crests, cones, flutes and poles can be developed. Similar structures not so strongly differ from what are shown on samples originally well polished. More and more than roughness are appeared on surfaces at increasing of ion fluence. Ones areas are sprayed more quickly than others because of defects of a crystal lattice. Etching poles which are the most typical kinds of the hollows resulting at dispersion are formed. They are formed as a result of selective dispersion of places of an output of screw dislocations on the surface. Poles are formed in local areas of the surface where there are those or other dislocations and where the energy of atom bond is lowered. The amount of poles grows with increasing of irradiation doze. They are blocked and increased in dimensions at an increase of an ion fluence. Obviously, at the energy of bombarding ions of 1.25 keV the effect of pole formation predominates and at enough high ion fluences they are the centers of homeotropic orientation of LC molecules.

Micropictures of silicon and germanium surfaces after argon ion bombardment with energy of 1.25 keV and ion fluence of $1.125 \cdot 10^{18}$ ion $\cdot$ см$^{-2}$ are shown on Fig.14. As seen, the relief on the surface of plates is different and, one is followed from Fig.12, corresponds to different types of LC molecule orientation.



a *b*

Fig.12. Micropictures of silicon (a) and germanium (b) surfaces after argon ion bombardment with energy of 1.25 keV and ion fluence of $1.125 \cdot 10^{18}$ ion · см$^{-2}$

The etchants of simple compound were used for experiments: the solution of KOH in water and ethylenglycol. A set of experiments with the solutions of different percentage compound, at different temperatures, and processing time was carried out for definition of optimal chemical processing regime. Plates of small dimensions were subjected by preliminary cleaning with acetone and spirit then their surfaces were observed under the optical microscope before and after processing operations.

The exact scales were used for preparation of KOH solutions. Preliminary cleared plates became covered on the one side by a layer of chemically proof glue and were maintained before its full hardening. It was done that only internal surfaces of optical cells were exposed to the subsequent etching. Then plates were fallen to the corresponding solution and all system was located in the thermostat with adjustable temperature.

In experiments the contents of alkali in solutions varied from 10 up to 50 %, thermostat temperature was increased up to 60˚C.

Observation under the optical microscope has shown that the most appreciable expression of plate surface after chemical etching occurs in the 30 percentage solution of KOH in ethylenglycol.

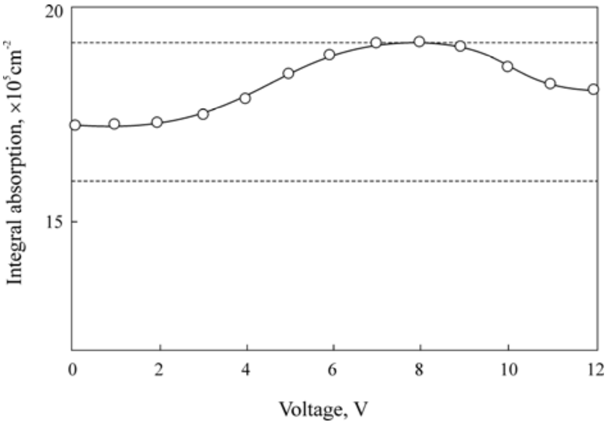


Fig.13. The dependence of integrated absorption from the applied voltage on the band with a maximum of 1630 cm^{-1} at preliminary processing of silicon plate by 30 % solution of KOH in ethyleneglycol.

The dependence of integrated absorption from applied voltage on the band with a maximum of 1630 cm^{-1} at processing silicon plates by the above-stated solution with concentration KOH equaled to 30 % at 60˚C is shown on Fig.13.

Apparently from Fig. 13, an initial part of the graph (voltage less than 3 V) situates above a corresponding part for cells with the non processed plates. It indicates that the preliminary etching of plates results in parallel orientation of LC molecules to the plate surface.

The concept of the degree of orientation order is entered for the quantitative description of primary orientation of LC molecules. Frequently [10-11], the degree of orientation order is defined with the help of known ratio $S = (N-1)/N+2)$, where $N = A_z/A_x$ – dichroic ratio; A_z and A_x - peak intensities of the chosen absorption band for two mutually perpendicular directions of light polarization.

In order to analyze our experimental results we shall accept a ratio of a difference between values of integrated absorption on the chosen band of the processed and non processed plates to a difference between values of integrated absorption on same band at the non processed plate without the application of field and at full planar orientation of LC molecules (U=7.5V). The dependence of degree of orientation order from concentration of KOH in water and ethyleneglycol is shown on Fig.14.

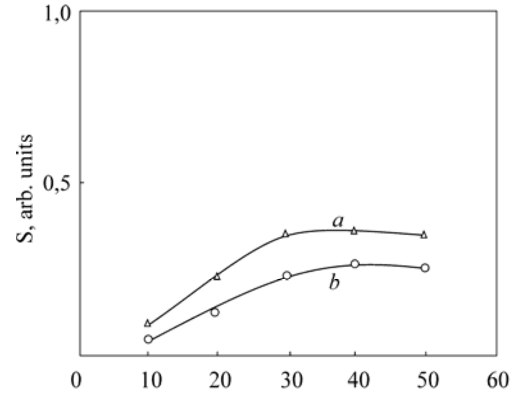


Fig.14. The dependence of degree of orientation order from concentration of KOH in water (a) and ethyleneglycol (b).

Apparently, the degree of orientation order reaches the maximal value at concentration of KOH equaled to 30 %. Thus, the degree of orientation order after etching by solution of KOH in ethyleneglycol is higher than one in water.

In order to obtain the maximal effect, both methods of surface processing of silicon are used. In the beginning, the surface of silicon is bombarded by argon ions with energy of 250 eV and ion fluence of $1.4 \cdot 10^{19}$ cm^{-2} then poisoned within 40 minutes in the 30 percentage solution of KOH in ethyleneglycol at 60˚C. The dependence of integrated absorption from voltage on the band with a maximum of 1630 cm^{-1} is shown on Fig.15.

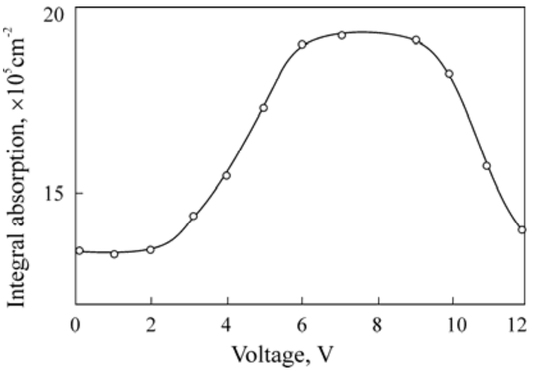


Fig.15. The dependence of integrated absorption from voltage on the band with a maximum of 1630 cm^{-1} for the plate processed by both methods.

Surface heterogeneities of nuclear scale arise during dispersion by the action of ionic bombardment. Similar effects can be observed both at falling separate ions and at the ion fluence reaching to 10^{16} cm^{-2} [12]. At even greater fluence there are microscopic observable heterogeneities with the sizes of 10-1000 nanometers. Enough high concentration of defects is collected inside the crystal at the ion fluence exceeding 10^{17} cm^{-2}. Thus there are local variations of dispersion factor leading to essential changes of morphology of the surface, namely, etching poles, conic or pyramidal ledges, and also wavy structures. Depth of penetration of ions in depth of a target is small, and dispersion factors are great at argon ion bombardment. It prevents to accumulation of greater concentration of impurities. At the same time, the rate of defect formation should be, apparently, high and the effects connected with defect formation should prevail on the effects caused by accumulation of implanted particles.

Defects are formed on a surface as a result of displacement of atoms and can occur at very small ion fluences. During the occurrence and annihilation of defects, the balance is not established between mechanisms of their formation, transformation and disappearance as there is an erosion of a surface at heavy ion fluences of 10^{13} cm^{-2} - 10^{17} cm^{-2}. There is a superfluous energy around of dislocations and defects which is connected to distortion of crystalline lattice. It is obvious, that chemical etchants act on these areas more strongly and promote formation of the centers of homeotropic orientation of LC molecules.

4. Conclusion

It is shown that at preliminary bombardment of substrates by argon ions with energy of 250 eV with increasing the ion fluence the LC molecules are oriented planarly while at energy of 1.25 keV with increasing of ion fluence they are done planarly and then - homeotropically. Preliminary chemical etching of substrates by solution of KOH in water and ethyleneglycol only promotes to planar orientation of LC molecules. The greatest effect homeotropic orientation of LC molecules is given with preliminary bombardment of substrates by argon ions with energy of 250 eV at the subsequent etching by solution of KOH in ethyleneglycol.

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SİLİSİUM VƏ GERMANİUM ALTLIQLARININ ƏVVƏLCƏDƏN ARQON İONLARI İLƏ BOMBARDMAN EDİLMƏSİNİN MAYE KRİSTAL MOLEKULLARININ DÜZÜLÜŞÜNƏ TƏSİRİ

Spektrin infraqırmızı (İQ) oblastında şəffaf Si və Ge altlıqlarının əvvəlcədən arqon ionları ilə bombardman edilməsindən və kimyəvi aşındırmadan sonra maye kristal (MK) molekullarının bircinsli düzülüşü imkanları tədqiq edilmişdir. MK molekullarının düzülüşü İQ – spektroskopiya və dielektrik ölçmələri ilə müəyyənləşdirilmişdir.

Müəyyən edilmişdir ki, altlıqları 250 eV enerjili arqon ionları ilə bombardman edərkən şüalanma dozasının artması ilə MK molekullarının düzülüşü planar olur, ionların enerjisi 1.25 eV olduqda isə, şüalanma dozasının artması ilə düzülüş əvvəlcə planar, sonra isə homeotrop olur. Altlıqların KOH-ın etilenqlikol və su məhlullarında əvvəlcədən kimyəvi aşındırılması MK molekullarının yalnız planar düzülüşünə gətirir. MK molekullarının homeotrop düzülüşünə ən güclü təsir isə altlığın 250 eV enerjili arqon ionları ilə bombardman edilməsi və KOH-ın etilenqlikol məhlulunda sonrakı aşındırılması verir.

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ВЛИЯНИЕ ПРЕДВАРИТЕЛЬНОЙ БОМБАРДИРОВКИ КРЕМНИЕВЫХ И ГЕРМАНИЕВЫХ ПОДЛОЖЕК ИОНАМИ АРГОНА НА ОРИЕНТАЦИЮ ЖИДКОКРИСТАЛЛИЧЕСКИХ МОЛЕКУЛ

Исследована возможность однородной ориентации молекул жидкого кристалла (ЖК) после предварительной бомбардировки подложек (Si, Ge), прозрачных в инфракрасной (ИК) области спектра, ионами аргона, а также после химического травления. Контроль ориентации молекул ЖК производится методами ИК спектроскопии и диэлектрическими измерениями.

Установлено, что при предварительной бомбардировке подложек ионами аргона с энергией 250 эВ с увеличением дозы облучения молекулы ЖК ориентируются планарно, а при энергии ионов 1,25 эВ с ростом дозы облучения сначала планарно, а затем гомеотропно. Предварительное химическое травление подложек КОН в воде и этиленгликоле способствует только планарной ориентации молекул ЖК. Наибольший эффект гомеотропной ориентации молекул ЖК дает предварительная бомбардировка подложек ионами аргона с энергией 250 эВ с последующим травлением раствором КОН в этиленгликоле.

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