Far-infrared intersubband absorption in *p*-type GaAs/$Al_xGa_{1-x}As$ single heterojunctions under uniaxial compression

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Theoretical calculations of intersubband light absorption spectra in *p*-type (001)GaAs/$Al_xGa_{1-x}As$ single heterojunctions under uniaxial compression have been performed. The absorption spectrum is characterized by a set of peaks at zero pressure and suffers considerable transformation under uniaxial compression. At nonzero pressure, the absorption of light with polarization perpendicular to the direction of the compression is smaller then the absorption of light with polarization parallel to the direction of the compression for the most values of photon energy. It has been demonstrated that the dependence of probability of transitions between subbands with the same value of the total angular momentum on the quasi-wave vector differs from the dependence of probability of transitions between subbands with different values of the total angular momentum.

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I. INTRODUCTION

Optical absorption due to intersubband transitions in GaAs heterostructures attracted considerable attention in the last decade in view of the perspective of their application as infrared photodetectors. Usually, *n*-type heterostructures having higher mobility and optical sensitivity than *p*-type heterostructures are considered to be a preferable material for optical devices. Nevertheless, *p*-type systems are also significant for optical applications due to specific features of the hole energy spectrum. Intersubband light absorption in *n*-type quantum wells (QW's) is possible only for light polarized perpendicularly to the heterointerface.[1,2] In *p*-type heterostructures, normally incident light is absorbed[2] due to the mixing of heavy- and light-hole states,[3–6] that makes these structures more attractive for optical applications. The intersubband absorption due to transitions between hole subbands in *p*-type GaAs/$Al_xGa_{1-x}As$/GaAs symmetric QW's was theoretically considered in Ref. 8. The photon with energy higher than the depth of the subband level in a QW causes a transition between this level and the continuum spectrum.[9] Experimental investigations of the light absorption due to intersubband transitions were carried out on GaAs/$Al_xGa_{1-x}As$ heterostructures[10–12] and $Hg_{1-x}Zn_xTe$/CdTe superlattices.[13]

The problem of strain influence on optical properties of two-dimensional systems is very important from both fundamental and technical points of view. Previous theoretical and experimental investigations of the effect mostly considered direct optical transitions between valence- and conduction-band states,[14–18] and no attention was paid to the problem of the anisotropy of optical properties in the case of uniaxial strain. Application of uniaxial compression leads to the strong anisotropy of the subband dispersion and the Fermi surface in *p*-type heterostructures.[6] Because of this fact, the absorption of light with polarization parallel to the heterointerface in uniaxially stressed *p*-type GaAs/$Al_xGa_{1-x}As$ heterostructures may be sensitive to the direction of light polarization.

In the present paper, we consider a single *p*-type (001)GaAs/$Al_{0.5}Ga_{0.5}As$ heterojunction in which the confining potential forms a ''triangular'' QW. The absence of inversion symmetry in the asymmetric QW leads to a spin-splitting of hole subbands[3–6] at nonzero wave vector. This effect allows transitions not only between subbands with different quantum numbers but also between spin-splitted subbands. In the next section (Sec. II) we describe a general model used for calculations of the light absorption spectra in a QW under uniaxial compression. In Sec. III we discuss the results of numerical calculation of light absorption in a single *p*-type (001)GaAs/$Al_{0.5}Ga_{0.5}As$ heterojunction under uniaxial compression.

II. THEORY

For the band-structure calculation we used 4×4 Luttinger-Kohn Hamiltonian[19] with the four topmost Γ_8 valence bands, that was written in the representation of the total angular momentum $J=\frac{3}{2}$ and strain terms were taken into account according to the Bir-Pikus description[20]

$$H=\begin{bmatrix} P+Q & R & -S & 0 \\ R^* & P-Q & 0 & S \\ -S^* & 0 & P-Q & R \\ 0 & S^* & R^* & P+Q \end{bmatrix}, \tag{1}$$

where

$$P\pm Q=-\frac{\hbar^2}{2m_e}[(\gamma_1\pm\gamma_2)(k_x^2+k_y^2)+(\gamma_1\mp2\gamma_2)k_z^2] - a_v(\varepsilon_{xx}+\varepsilon_{yy}+\varepsilon_{zz})\mp b\left[\varepsilon_{zz}-\frac{1}{2}(\varepsilon_{xx}+\varepsilon_{yy})\right], \tag{2}$$

$$R=-\frac{\hbar^2\sqrt{3}}{2m_e}[\gamma_2(k_x^2-k_y^2)-2i\gamma_3 k_x k_y] - \frac{\sqrt{3}}{2}b(\varepsilon_{yy}-\varepsilon_{xx})-id\varepsilon_{xy}, \tag{3}$$

$$S=-i\frac{\hbar^2}{m_e}\gamma_3\sqrt{3}(k_x-ik_y)k_z+d(\varepsilon_{yz}+i\varepsilon_{zx}). \tag{4}$$

Here, a_v, b, and d are the deformation potentials for the valence band, ε_{ij} are the components of the strain tensor, m_e is the free-electron mass, γ_i are the Luttinger constants, k_i are the components of the quasiwave vector. This 4×4 matrix can be reduced to two 2×2 matrices by using the unitary transformation $H'=UHU^{+}$[5,6]

$$H'=\begin{bmatrix} P+Q & A & 0 & 0 \\ A^* & P-Q & 0 & 0 \\ 0 & 0 & P-Q & A \\ 0 & 0 & A^* & P+Q \end{bmatrix}, \tag{5}$$

where

$$A=|R|-i\frac{\sqrt{3}\hbar^2}{m_e}\gamma_3\sqrt{(k_x^2+k_y^2)}k_z, \tag{6}$$

and the transformation U is

$$U=\frac{1}{\sqrt{2}}\begin{bmatrix} e^{-i\varphi} & 0 & 0 & -e^{i\varphi} \\ 0 & e^{-i\eta} & -e^{i\eta} & 0 \\ 0 & e^{-i\eta} & e^{i\eta} & 0 \\ e^{-i\varphi} & 0 & 0 & e^{i\varphi} \end{bmatrix}. \tag{7}$$

The angles φ and η are determined from

$$\varphi=\frac{\pi}{4}+\frac{1}{2}(\alpha+\beta),\quad \eta=\frac{\pi}{4}-\frac{1}{2}(\alpha-\beta), \tag{8}$$

and

$$\tan(\alpha)=-\frac{\frac{\hbar^2}{m_e}\sqrt{3}\gamma_3 k_x k_y-d\varepsilon_{xy}}{\frac{\hbar^2}{2m_e}\sqrt{3}\gamma_2(k_x^2-k_y^2)+\frac{\sqrt{3}}{2}b(\varepsilon_{yy}-\varepsilon_{xx})},$$

$$\tan(\beta)=-\frac{\frac{\hbar^2}{m_e}\sqrt{3}\gamma_3 k_x k_z-d\varepsilon_{zx}}{d\varepsilon_{yz}-\frac{\hbar^2}{m_e}\sqrt{3}\gamma_3 k_y k_z}. \tag{9}$$

We choose the z direction to be perpendicular to the heterointerface (001). A self-consistent potential $V(z)$, calculated in the depletion-layer approximation, is added along the matrix diagonal and k_z is replaced by the operator $(1/i)\partial/\partial z$. The detailed procedure of the calculations is described in Ref. 6. The calculations of the band structure have been performed using the finite-difference method.

In order to obtain a transition probability, we used the first-order perturbation theory. In this approximation, an external field interaction operator can be written as

$$H_{int}=-\frac{e}{c\hbar}\frac{\partial H(\mathbf{k})}{\partial\mathbf{k}}\mathbf{A}(\mathbf{r},t). \tag{10}$$

Here, $\mathbf{A}(\mathbf{r},t)$ is the vector potential of electromagnetic field

$$\mathbf{A}(\mathbf{r},t)=\sum_{\mathbf{q},\nu}\sqrt{\frac{2\pi c^2\hbar}{\epsilon\omega V}}\mathbf{e}_{\mathbf{q}}^{\nu}(b_{\mathbf{q}\nu}e^{i(\mathbf{qr}-\omega t)}+b_{\mathbf{q}\nu}^{+}e^{-i(\mathbf{qr}-\omega t)}), \tag{11}$$

where $\mathbf{q}$ is the wave vector of the photon with the frequency ω and polarization ν, $\mathbf{e}_{\mathbf{q}}^{\nu}$ is the light polarization unit vector, $b_{\mathbf{q}\nu}$ and $b_{\mathbf{q}\nu}^{+}$ are the photon creation and destruction operators, ϵ is the dielectric constant, V is the volume. According to the Fermi's golden rule,[21,22] we can write the total transition probability $W_{ij}(\omega)$ between subbands i and j with energy E_i and E_j at zero temperature

$$W_{ij}(\omega)=\frac{2\pi}{\hbar}\int_{\substack{|E_i(\mathbf{k}_\parallel)|<|E_f| \\ |E_j(\mathbf{k}_\parallel)|>|E_f|}}|\langle\mathbf{\Psi}_i^*\Phi_n^*|H_{int}|\mathbf{\Psi}_j\Phi_{n-1}\rangle|^2 \times\delta(E_i-E_j-\hbar\omega)d\mathbf{p}, \tag{12}$$

where E_f is the Fermi energy, $\mathbf{\Psi}_i$ and $\mathbf{\Psi}_j$ are the wave functions of the Hamiltonian, Φ_n and Φ_{n-1} are the wave functions of electromagnetic field, $\mathbf{p}$ is the momentum. Subband i corresponds to the one of the spin subbands of the spin-splitted ground state and the transitions occur from the filled ground states below the Fermi level to the free states above the Fermi level. In the long wavelength region $e^{-i\mathbf{qr}}$ can be replaced by one. Taking into account that $|\langle\Phi_n|b_{\mathbf{q}\nu}^{+}|\Phi_{n-1}\rangle|^2=n_\omega$, where n_ω is the number of photons with the frequency ω in the volume V, the matrix element of the transition between i and j subbands can be written as

$$\langle i|H_{int}|j\rangle=-\sqrt{\frac{2\pi e^2 n_\omega}{\epsilon\hbar\omega V}}\int_V\Psi_i^*(\mathbf{r})\left(\frac{\partial H(\mathbf{k})}{\partial\mathbf{k}}\mathbf{e}_{\mathbf{q}}^{\nu}\right)\Psi_j(\mathbf{r})d\mathbf{r}, \tag{13}$$

and Eq. (12) is written as

$$W_{ij}(\omega)=\frac{4\pi^2e^2n_\omega}{\hbar^2\epsilon\omega V}\int_{\substack{|E_i(\mathbf{k})|<|E_f| \\ |E_j(\mathbf{k})|>|E_f|}}d\mathbf{p}\,\delta(E_i-E_j-\hbar\omega) \times\left|\int_V\Psi_i^*(\mathbf{r})\left(\frac{\partial H(\mathbf{k}_\parallel)}{\partial\mathbf{k}_\parallel}\mathbf{e}_{\mathbf{q}}^{\nu}\right)\Psi_j(\mathbf{r})d\mathbf{r}\right|^2. \tag{14}$$

The factor $[f(E_i)-f(E_j)]$ must be added in Eq. (12) in the case of nonzero temperature, where f is the Fermi-Dirac distribution. For modeling various broadening mechanisms, the δ function is replaced by Gaussian with the width parameter Γ

$$\delta(E_i-E_j-\hbar\omega)\rightarrow\frac{1}{\sqrt{2\pi}\Gamma}\exp\left(-\frac{(E_i-E_j-\hbar\omega)^2}{2\Gamma^2}\right). \tag{15}$$

For a single quantum well the light absorption $A(\omega)$ can be defined as a ratio between the absorbed part of the light flow to the total light flow I_0. This flow through the normal unit area S fills the volume with the length $c/\sqrt{\epsilon}$ per time unit by the number of photons $n_\omega = I_0$. So the light absorption $A(\omega)$ can be obtained by replacing the volume V in Eq. (14) by $c/\sqrt{\epsilon}$, summarizing all these volumes along the z direction and dividing by the total light flow I_0.

Taking into account the form of the wave function Ψ of the Hamiltonian (1) in the envelope function approximation

$$\mathbf{\Psi} = \begin{bmatrix} \Psi_1(z) \\ \Psi_2(z) \\ \Psi_3(z) \\ \Psi_4(z) \end{bmatrix} e^{i(k_x x + k_y y)}, \tag{16}$$

and the two dimensionality of the system, the absorption of normally incident light is written as

$$A(\omega) = \frac{e^2}{\sqrt{\epsilon} c \hbar^2 \omega} \int_{\substack{|E_i(\mathbf{k}_\parallel)|<|E_f| \\ |E_j(\mathbf{k}_\parallel)|>|E_f|}} d\mathbf{k}_\parallel \frac{1}{\sqrt{2\pi}\Gamma} \times \exp\left(- \frac{(E_i - E_j - \hbar\omega)^2}{2\Gamma^2} \right) \times \left| \int \Psi_i^*(z) \left(\frac{\partial H(\mathbf{k}_\parallel)}{\partial \mathbf{k}_\parallel} \mathbf{e}_\mathbf{q}^\nu \right) \Psi_j(z) dz \right|^2 [f(E_i) - f(E_j)]. \tag{17}$$

III. RESULTS AND DISCUSSION

The numerical calculations have been performed for the *p*-type (001)GaAs/$Al_{0.5}Ga_{0.5}As$ single heterojunction with the total hole concentration 7.6×10^{11} cm^{-2}. Values of the deformation potentials $a_v = -1.6$ eV, $b = -1.7$ eV, $d = -4.55$ eV and other parameters are taken to be the same as in Ref. 6. For a more realistic description of light absorption spectra, we take the level broadening parameters $\Gamma = 1.75$ meV according to Refs. 7 and 8. We consider normally incident light with linear polarization as well.

In the following description we take into account only the first five levels in the quantum well that determine the low-energy region of light absorption. The subbands with higher quantum numbers should be taken into account for the calculation of light absorption in a wider range of wavelength. Our main conclusions are based on the specific features of the hole subband dispersion and its anisotropy under uniaxial compression. Therefore, they are also valid for the consideration of transitions to higher excited subbands.

Due to the lack of the confining potential symmetry in a triangular QW each level is spin splitted at a nonzero value of quasi-wave vector $\mathbf{k}_\parallel$ and has the nonparabolic and anisotropic subband dispersion[6] (Fig. 1). At the total hole concentration 7.6×10^{11} cm^{-2}, only two subbands (spin subbands) of the spin-splitted ground heavy-hole state are populated. In this case, the Fermi surface consists of two parts: a circle corresponding to the spin subband ''1'' with more light effective mass, and a goffered circle corresponding to the spin subband ''0'' with more heavy effective mass.[4,6] This fact leads to the two series of transitions: transitions between states described by the same block of matrix (5) and transitions between states described by the different blocks of matrix (5). We will use letters ''U'' and ''L'' to denote the upper and lower blocks. Thus, ''$U1L3$'' means the transition from the first subband of the upper block to the third subband of the lower block (see Fig. 1).

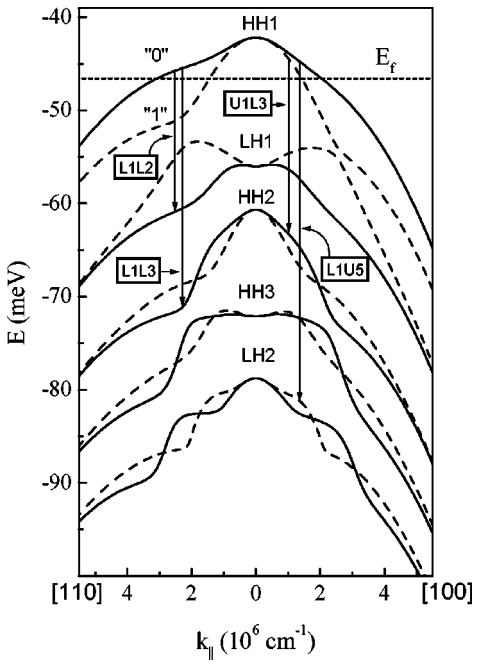

FIG. 1. Energy of the first five hole subbands in the *p*-type (001)GaAs/$Al_{0.5}Ga_{0.5}As$ heterojunction ($N_s = 7.6\times10^{11}$ cm^{-2}) versus $k_\parallel$ parallel to [100] and [110] directions at $P = 0$. Dashed and solid lines correspond to the states described by the upper and lower blocks of matrix (5). Dotted line is the position of the Fermi level. Several possible optical transitions are marked by arrows.

Transitions inside the same block of matrix (5) and transitions between the different blocks correspond to different parts of the matrix element $\langle \Psi_i | \partial H / \partial \mathbf{k} \mathbf{e}_\mathbf{q}^\nu | \Psi_j \rangle$. If we multiply the matrix element by U^+U at left and at right and take into account that $\Psi' = U\Psi$ and $H' = UHU^+$, the matrix element can be represented in the form

$$\left\langle \Psi_i \left| \frac{\partial H}{\partial \mathbf{k}} \mathbf{e}_\mathbf{q}^\nu \right| \Psi_j \right\rangle = \left\langle \Psi_i' \left| \frac{\partial H'}{\partial \mathbf{k}} \mathbf{e}_\mathbf{q}^\nu \right| \Psi_j' \right\rangle - \left\langle \Psi_i' \left| \frac{\partial U}{\partial \mathbf{k}} H U^+ \mathbf{e}_\mathbf{q}^\nu \right| \Psi_j' \right\rangle - \left\langle \Psi_i' \left| U H \frac{\partial U^+}{\partial \mathbf{k}} \mathbf{e}_\mathbf{q}^\nu \right| \Psi_j' \right\rangle. \tag{18}$$

Expression HU^+ in Eq. (18) can be replaced by U^+H', and UH by $H'U$. So far, as Ψ' is an eigenfunction of the Hamiltonian H', we have $H'\Psi_j' = E_j(\mathbf{k})\Psi_j'$. Under this condition, Eq. (18) can be written as

$$\left\langle \Psi_i \left| \frac{\partial H}{\partial \mathbf{k}} \mathbf{e}_{\mathbf{q}}^{\nu} \right| \Psi_j \right\rangle = \left\langle \Psi_i' \left| \frac{\partial H'}{\partial \mathbf{k}} \mathbf{e}_{\mathbf{q}}^{\nu} \right| \Psi_j' \right\rangle - \left\langle \Psi_i' \left| \frac{\partial U}{\partial \mathbf{k}} U^{+} \mathbf{e}_{\mathbf{q}}^{\nu} \right| \Psi_j' \right\rangle E_j(\mathbf{k}) - \left\langle \Psi_i' \left| U \frac{\partial U^{+}}{\partial \mathbf{k}} \mathbf{e}_{\mathbf{q}}^{\nu} \right| \Psi_j' \right\rangle E_i(\mathbf{k}). \quad (19)$$

The transformation U is unitary and so $\partial/\partial\mathbf{k}(UU^{+})=0$. According to this expression, the matrix element is given by

$$\left\langle \Psi_i \left| \frac{\partial H}{\partial \mathbf{k}} \mathbf{e}_{\mathbf{q}}^{\nu} \right| \Psi_j \right\rangle = \left\langle \Psi_i' \left| \frac{\partial H'}{\partial \mathbf{k}} \mathbf{e}_{\mathbf{q}}^{\nu} \right| \Psi_j' \right\rangle + \left\langle \Psi_i' \left| U \frac{\partial U^{+}}{\partial \mathbf{k}} \mathbf{e}_{\mathbf{q}}^{\nu} \right| \Psi_j' \right\rangle (E_j - E_i). \quad (20)$$

The matrix $U\partial U^{+}/\partial\mathbf{k}$ in Eq. (20) is simplified to

$$U\frac{\partial U^{+}}{\partial \mathbf{k}} = \frac{1}{2}\begin{bmatrix} 0 & 0 & 0 & \frac{\partial\varphi}{\partial\mathbf{k}} \\ 0 & 0 & \frac{\partial\eta}{\partial\mathbf{k}} & 0 \\ 0 & \frac{\partial\eta}{\partial\mathbf{k}} & 0 & 0 \\ \frac{\partial\varphi}{\partial\mathbf{k}} & 0 & 0 & 0 \end{bmatrix}. \quad (21)$$

This transformation inverts the column of the eigenfunction Ψ'. So, according to Eq. (20), the matrix element consists of two terms. The first one, which is similar to the total matrix element, corresponds to the transitions between states inside one of the blocks of matrix (5). The second term corresponds to the transitions between the different blocks of the matrix. The presence of the second term is explained by the fact that the unitary transformation U depends on the value of quasiwave vector $\mathbf{k}$. If the transformation U were the same for all values of $\mathbf{k}$, it would be possible to use directly the Hamiltonian H' and its eigenfunctions Ψ' in Eq. (17) instead of H and Ψ. Whereas these two series of the transitions are described by different terms, it is reasonable to expect that they have different probabilities.

Figures 2 and 3 show results of calculations of squared momentum matrix elements for the triangular quantum well as functions of the quasi-wave vector at zero pressure and under uniaxial compression ($P=5$ kbar) applied along the [110] and $[1\bar{1}0]$ directions. The validity of the above-discussed suggestion is clear from the figures. The behavior of matrix elements corresponding to transitions inside the same block of matrix (5) differs from the behavior of matrix elements corresponding to transitions between the different blocks. For example, the probability of the transition $L1U2$ increases with an increase of $\mathbf{k}_{\|}$ near to zero value $\mathbf{k}_{\|}$, whereas the probability of the transition $L1L2$ decreases. The similar behavior takes place for the $L1L5$ and $L1U5$ transitions.

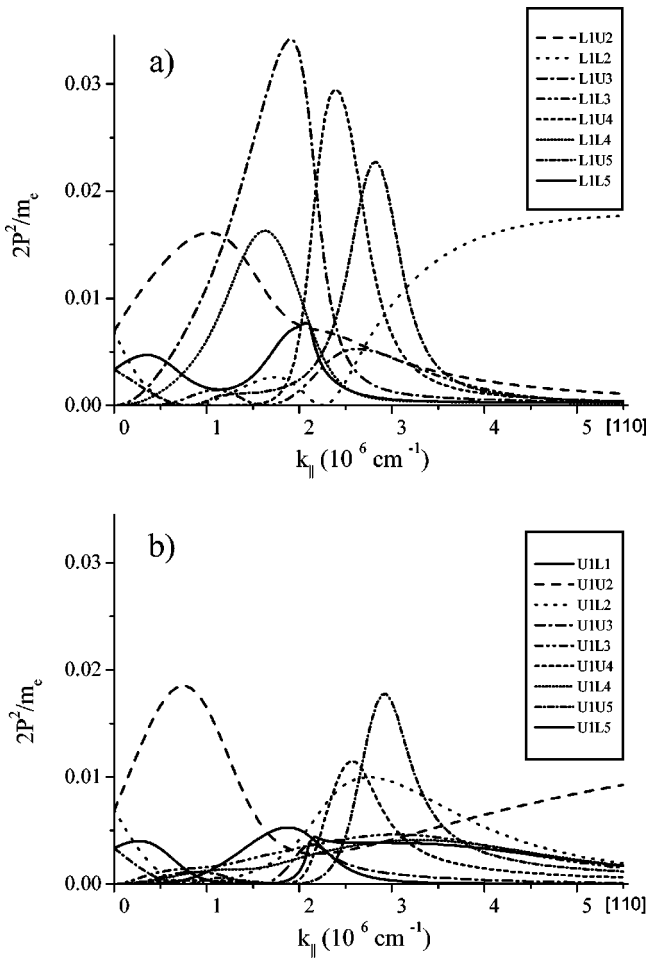

FIG. 2. Squared momentum matrix elements for the *p*-type (001)GaAs/$Al_{0.5}Ga_{0.5}$As single heterojunction at zero pressure and light polarized along the [110] direction. The transitions from subband $L1$ are shown in figure (a) and the transitions from subband $U1$ are shown in Figure (b). U and L denote transitions corresponding to the states described by the upper and lower blocks of matrix (5).

Uniaxial compression has affects on matrix elements, as well as on the energy spectrum. As can be seen from Fig. 3(b) at $P=5$ kbar for light polarization perpendicular to the direction of uniaxial compression, there are three dominating transitions labeled ''$L1L4$,'' ''$U1U4$,'' ''$L1U5$,'' at low values of $\mathbf{k}_{\|}$ and two dominating transitions labeled ''$L1L2$,'' ''$U1U2$'' at high values of $\mathbf{k}_{\|}$. All other transitions have significantly smaller probabilities in this case [only few of the corresponding squared momentum matrix elements are plotted on Fig. 3(b)]. The results for momentum matrix elements obtained under uniaxial compression for light polarization parallel to the direction of the compression is more complicated [Fig. 3(a)]. In this case, approximately half of the transitions have considerable probability and one of the transitions is more prominent—$L1L4$ ($U1U4$). The breaks in the transition curves are caused by the touching points in the energy spectrum[6] and depend on how we mark the subbands before and after touching point. In our case, we use Hamiltonian (5), therefore subbands $U1$ and $U4$ become

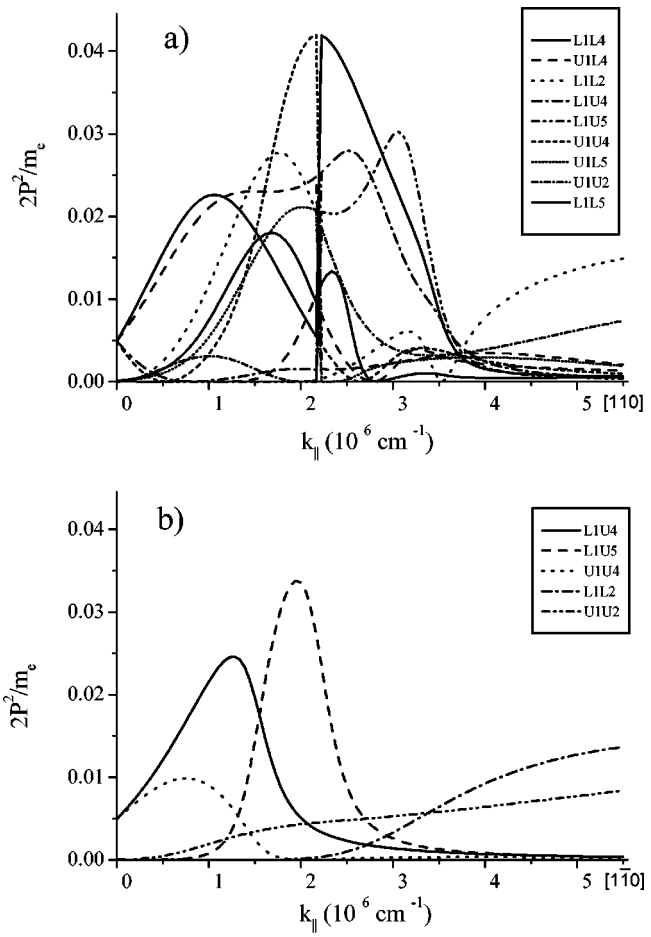

FIG. 3. Squared momentum matrix elements for the *p*-type (001)GaAs/$Al_{0.5}Ga_{0.5}$As single heterojunction at uniaxial compression $P=5$ kbar applied along the [110] direction: (a) light polarized along the [110] direction, (b) light polarized along the [1$\bar{1}$0] direction. *U* and *L* denote transitions corresponding to the states described by the upper and lower blocks of matrix (5).

$L1$ and $L4$, respectively, after the touching points.[6] If Hamiltonian is used in form (1) instead of (5), there is no change of the subband names in touching points, and as a result, the breaks do not appear. Therefore, in our case, two different matrix elements (for example, $L1L4$ and $U1U4$) characterize the same optical transition, one before touching point and another after it.

Application of external uniaxial compression significantly modifies subband dispersion,[6] and leads to the considerable transformation of intersubband absorption spectra. The results of calculations for different values of uniaxial compression applied along [110] and [100] directions are presented in Figs. 4 and 5. The absorption spectrum is characterized by a set of peaks at zero pressure, it suffers considerable transformation under uniaxial compression: new peaks arise, some of the peaks change their magnitude and some of them vanish with an increase of compression. The presence of uniaxial compression causes strong anisotropy of light absorption in respect to light polarization. Stress-induced anisotropy of optical absorption is determined by the direction of applied uniaxial compression: the uniaxial compression leads to a decrease of the absorption of light with all directions of polarization, but the absorption of light with polarization perpendicular to the direction of the compression decreases faster under compression than the absorption of light with polarization parallel to the direction of the compression. As a result, the optical absorption is anisotropic for different light polarization under in-plane uniaxial compression. This strong anisotropy is caused by the anisotropy of the subband dispersion.

The origin of the anisotropy of light absorption investigated in this paper is similar to the origin of (observed experimentally and confirmed theoretically) considerable anisotropy of kinetic properties of two-dimensional holes in (001)GaAs/$Al_{0.5}Ga_{0.5}$As quantum wells.[6] So far as the anisotropy of light absorption in *p*-type GaAs/Al_xGa_{1-x}As heterostructures is caused by the energy spectrum transforma-

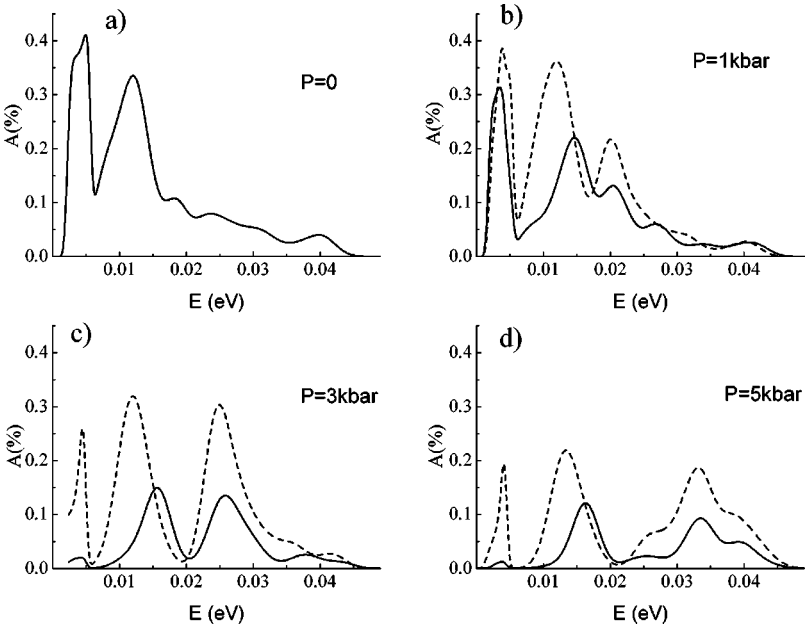

FIG. 4. Calculated light absorption spectra in the *p*-type (001)GaAs/$Al_{0.5}Ga_{0.5}$As single heterojunction under uniaxial compression applied along [110] direction: (a) $P=0$, (b) $P=1$ kbar, (c) $P=3$ kbar, (d) $P=5$ kbar. Solid and dashed lines correspond to the absorption of light with polarization perpendicular and parallel to the direction of applied compression, respectively.

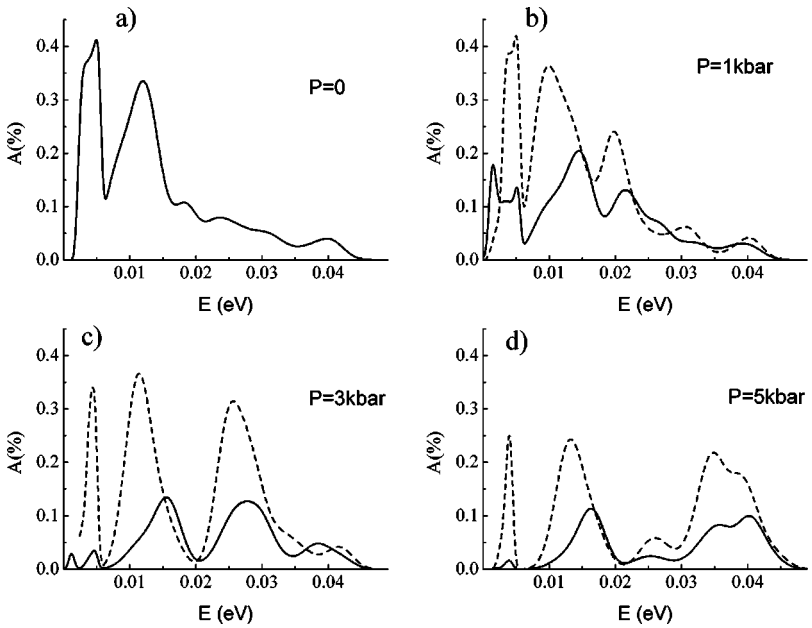

FIG. 5. Calculated light absorption spectra in the *p*-type (001)$GaAs/Al_{0.5}Ga_{0.5}As$ single heterojunction under uniaxial compression applied along [100] direction: (a) $P=0$, (b) $P=0.5$ kbar, (c) $P=1$ kbar, (d) $P=5$ kbar. Solid and dashed lines correspond to the absorption of light with polarization perpendicular and parallel to the direction of applied compression, respectively.

tion under in-plane uniaxial compression, it is reasonable to expect similar anisotropic behavior of light absorption corresponding to the transitions between valence- and conduction-band states and bound-free transitions.

IV. CONCLUSION

Results of theoretical calculations of light absorption in the far-infrared region in the *p*-type (001)$GaAs/Al_{0.5}Ga_{0.5}As$ single heterojunction under uniaxial compression have been presented in this paper. We have examined both [110] and [100] directions of uniaxial compression and demonstrated stress-induced anisotropy of absorption of light with different polarization. The light absorption spectrum is characterized by a set of peaks at zero pressure and it suffers considerable transformation under uniaxial compression: new peaks arise, some of the peaks change their magnitude and some of them vanish with an increase of compression. The absorption of the light with polarization perpendicular to the direction of the compression is smaller than the absorption of the light with polarization parallel to the direction of the compression for the most values of photon energy at nonzero pressure. It has been demonstrated that the dependence of probability of transitions between subbands with the same value of the total angular momentum on the quasi-wave vector differs from the dependence of probability of transitions between subbands with different values of the total angular momentum on the quasi-wave vector.

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