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G.B. GRIGORYAN, O.H. PETROSYAN, H.R. AVETISYAN, A.G. POGHOSYAN, A.A. KHZARJYAN, S.S. AVETISYAN

THE EFFECTS OF NUCLEAR RADIATION ON SEMICONDUCTOR THIN FILMS

The effect of nuclear radiation on the semiconductor crystal, depending on the radiation energy and on the intensity may be different. At low intensities, in the crystal-formed positions, there are no minimum number of atoms. In such vacancies can be localized carriers in a bound state. This feature should be taken into account when considering a nanofilm in which carriers are in a strong size quantization. Size quantization energy is much higher than the energy of localization of carriers at defects that occur during the radiation, therefore the impact of nuclear radiation on the state of the carriers can be taken into account as a perturbation. Calculations of optical absorption coefficient nanofilms show that the effect of nuclear radiation on a thin film reduces its ability to absorb light.

Keywords: semiconductor thin film, γ radiation, δ potential, optical absorption, light and heavy holes.

Introduction. The study of radiation effects in semiconductor electronics and the development of radiation- resistant integrated circuits have formed scientific community that has produced a wealth of data and conceptual understanding. This is a very complicated field, and developing a general theory for investigation is not easy, but one can apply a few fundamental considerations to the understanding of the effects of radiation on the device types with nano-scale components and narrow the range of options that must be studied in detail.

Semiconductor devices are affected by two basic radiation damage mechanisms: incident radiation displaces atoms from their lattice sites, and the resulting defects alter the electronic characteristics of the crystal, and second, the energy absorbed by electronic ionization liberates the charge carrier which diffuses or drifts to other locations where it is trapped, leading to unintended concentrations of charge and, as a consequence, parasitic fields.

Displacement damage. An incident particle or photon is capable of dislodging the lattice atoms from its lattice site. Displacement damage creates defect clusters. For example, a 1MeV neutron transfers about 60 to 70 keV to the Si recoil atom, which in turn displaces roughly 1000 additional atoms in a region of about 0.1μm in size. Displacement damage is proportional to non-ionizing energy loss which is not proportional to the total energy absorbed, but depends on the particle type and energy [1].

X-rays do not cause a direct displacement damage, since the momentum conservation sets a threshold energy of 250keV for photons. Co^{60}γ-rays cause displacement damage primarily through Compton electrons and are about three order of magnitude less damaging per photon than the 1MeV neutron [2].

Radiation damage in thin films. Nanofilm structures are basic components of more complex devices, for example bipolar transistors, detector diodes (on the superlattice), photodiode at the design of the electronic systems is governed by changes in transistor parameters under irradiation. Amplifiers are sensitive to changes in gain, bandwidth, and noise.

A theoretical analysis from the first principles is quite complex, due to many phenomena involved.

The physical model. A detailed study of the optical properties of semiconductor structures takes into consideration the different spin states of the holes. This means that the condition of the hole should be characterized by the Luttinger Hamiltonian [8]:

$$H\left(z, k_z = \frac{1}{i}\frac{d}{dz}\right) = \begin{bmatrix} P+Q & -R & S & 0 \\ -R^+ & P-Q & 0 & -S \\ S^+ & 0 & P-Q & -R \\ 0 & -S^+ & -R^+ & P+Q \end{bmatrix}, \qquad (1)$$

where $P=\frac{\hbar^2}{2m_0}\left[\gamma_1\left(k_x^2+k_y^2\right)-\frac{d}{dz}\gamma\frac{d}{dz}\right]$, $Q=\frac{\hbar^2}{2m_0}\left[\gamma_2\left(k_x^2+k_y^2\right)+2\frac{d}{dz}\gamma\frac{d}{dz}\right]$,

$$S=\frac{\sqrt{3}\hbar^2}{im_0}\gamma\left(k_x-ik_y\right)\frac{d}{dz}, \quad R=\frac{-\sqrt{3}\hbar^2}{2m_0}\gamma\left(k_x+ik_y\right)^2,$$

m_0 – is the free electron mass, γ_1, γ - the Luttinger parameters.

Taking into consideration the states of heavy and light holes in the calculation of the absorption coefficient for CdTe quantum nanocrystals allows to fully explain the experimentally observed behavior [9]. The radiation defects of the semiconductor nano-films is considered as spherical quantum wells, where the electrons and holes can be localized based on the quantum size levels. Electrons and holes under these conditions move in a potential:

$$U(z) = \begin{cases} \alpha\delta(z), |z| < a \\ \infty, |z| < a \end{cases}$$

The Delta function in the potential means that the radiation defects are small and have quantum wells containing only one quantum size level. A spherical quantum well has at least one electron quantum level if the gap conduction bands at the heterojunction ΔEc exceeds $\frac{\hbar^2}{2m_e}\left(\frac{\pi}{d_{\min}}\right)^2$, m_e is the effective electron mass, and $d_{\min}$ is the minimum size of the spherical quantum well that contains at least one energy level [10].

In a quantum system GaAs-$Al_{0.4}Ga_{0.6}As$ ΔE_c= 0.3eVand $d_{\min}$ = 60å. The wave functions and energies of quantized holes for the film are take, from [11].

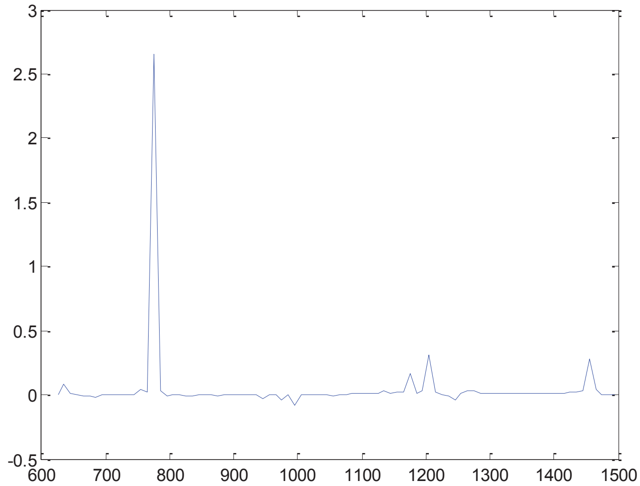

Fig. 1. Optical transition matrix element before irradiation

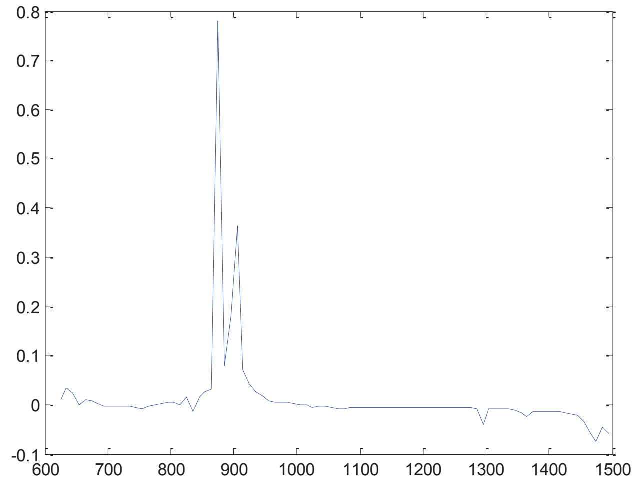

Fig. 2. The optical transition matrix element after irradiation

Figures 1 and 2 show the dependence of the square of the matrix element of the optical transition between the hole levels and a single electronic level on the wavelength of the incident light. Accounting for the effects of radiation defects as spherical quantum wells in the state of holes is considered as a small perturbation on their states in a quantized film.

Conclusion. Radiation-induced defects at certain levels of their appearance can greatly affect the optical absorption spectrum of the semiconductor film with n-type conductivity. In the case of the quantized film $GaAs\text{-}Al_{0.4}Ga_{0.6}As$, absorption peaks shift to longer wavelengths, and split into two closely spaced peaks, and their intensity decreases.

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Գ.Բ. ԳՐԻԳՈՐՅԱՆ, Օ.Հ. ՊԵՏՐՈՍՅԱՆ, Հ.Ռ. ԱՎԵՏԻՍՅԱՆ, Ա.Գ. ՊՈՂՈՍՅԱՆ, Ա.Ա. ԽՉԱՐՋՅԱՆ, Ս.Ս. ԱՎԵՏԻՍՅԱՆ

ՄԻՋՈՒԿԱՅԻՆ ՃԱՌԱԳԱՅԹՄԱՆ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ԲԱՐԱԿ ԿԻՍԱՀԱՂՈՐԴՉԱՅԻՆ ԹԱՂԱՆԹԻ ՎՐԱ

Հետազոտվել է միջուկային ճառագայթման ենթարկված բարակ կիսահաղորդչային թաղանթի օպտիկական կլանումը: γ ճառագայթման ազդեցության տակ բարակ թաղանթում առաջանում են վականսիաներ, որոնք հոսանքակիր մասնիկների համար հանդիսանում են δ պոտենցիալներ, և որոնցում լիցքավորված մասնիկները կարող են տեղայնացվել: Հաշվարկները ցույց են տալիս, որ օպտիկական կլանման ինտենսիվությունը էապես փոքրանում է δ պոտենցիալներ պարունակող բարակ թաղանթներում, որոնք հանդես են գալիս որպես տեղայնացման կենտրոններ էլեկտրոնների, ծանր և թեթև խոռոչների համար:

Առանցքային բառեր. բարակ կիսահաղորդչային թաղանթ, γ ճառագայթում, δ պոտենցիալ, օպտիկական կլանում, ծանր և թեթև խոռոչներ:

Г.Б. ГРИГОРЯН, О.А. ПЕТРОСЯН, Г.Р. АВЕТИСЯН, А.Г. ПОГОСЯН, А.А. ХЗАРЧЯН, С.С. АВЕТИСЯН

ВЛИЯНИЕ ЯДЕРНОГО ИЗЛУЧЕНИЯ НА ТОНКУЮ ПОЛУПРОВОДНИКОВУЮ ПЛЕНКУ

Исследовано оптическое поглощение тонкой полупроводниковой пленки, подверженной ядерному излучению. Под влиянием γ-излучения в тонкой пленке образуются вакансии, которые для носителей тока являются δ-потенциалами и в которых заряженные частицы могут локализоваться. Расчеты показали, что интенсивность оптического поглощения значительно уменьшается в тонкой пленке, содержащей δ-потенциалы, выступающие в качестве локализационных центров для электронов, тяжелых и легких дырок.

***Ключевые слова*:** тонкая полупроводниковая пленка, γ - излучение, δ - потенциал, оптическое поглощение, легкие и тяжелые дырки.

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A.M. SEDRAKYAN

A METHOD FOR IDENTIFYING AND REGISTERING THE ULTRA SMALL OPTICAL PARAMETERS OF PARASITES IN BIOMEDICINE

It is shown that accurate measurements of oscillations of the sick tissue cells of living organisms affected by mycobacteria cause various diseases relevant in the sphere of ophthalmology. On the basis of precise measurements and signal recording, a simple and effective method for the treatment of benign and cancerous tumors, susceptible (or aren't) to treatment is proposed.

Keywords: optical measurements, optical activity, gyrotropy, amplifying medium, biomedicine, ophthalmology.

Introduction. It is well known that the most important tissues of living organisms in biology (ophthalmology) are gyrotropnics. The effects of Gyrotropy are usually mild and the important task of optics becomes the development of methods of amplification to gain registration and examination of its effects. Gyrotropy is a powerful tool for the research and the study of the matter structure. The relevance of the research of parameters of gyrotropic substances are mainly due to the following circumstances: paltry asymmetric deformations. (Increase and decrease in the density of the mycobacteria, etc.) in order 0,001...0,005A^0 is enough to appear in the optically active environment. Strengthening and registration of such magnitudes for which we need to measure the change in the angle of the plane of the polarization of optical radiation is a major challenge of modern science. In practice, for the treatment of malignant and a number of benign diseases ionizing radiation is applied. Under the influence of this radiation, a huge number of mutations develop in the cells and they