INFLUENCE OF γ-IRRADIATION ON PHOTOCONDUCTIVITY AND PHOTOLUMINESCENCE OF MONOCRYSTALS GAS1,2SEX: Er

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1. INTRODUCTION
The influence of γ-irradiation with the energy E= 1.3 MeV and dose Dγ = 10^4-100 krad on photoelectric and photoluminescent properties of monocrystals GaS1,2Sex: Er (x= 0.25) was investigated. On basis of the analysis of experimental data it was established at doping rare earth element erbium N= 10^18sm^-3 by impurities and γ-irradiation photosensitivity and intensity of photoluminescent irradiation in the investigated samples increase. The model of defect formation was suggested, which explains the observed characteristics.

2. EXPERIMENTAL
The investigated monocrystals GaS1,2Sex:Er with specific resistance ρ~ 10^9 Ohm sm at room temperature were grown by Bridgman method. Doping of erbium was conducted in the process of growing. Concentration of erbium in the sample equaled to N= 10^18 sm^-3. Irradiation of the samples by γ-quanta with the energy 1.3 MeV (Dose Dγ= 10^4-100 krad) was carried out at gamma-ray unit Co60 at room temperature. Ohmic contacts are carried to opposite crystal surfaces by silver paste. Measurements of photoconductivity were conducted according to steady-state procedure [1].

Spectra of photoluminescence of the investigated samples were taken at spectrometer SDA-1. The spectrometer is composed of double monochromator with replaceable diffraction lattice, illuminator with lamp of DRS type, condenser, energy detector and amplifying-recording unit.

Mercury-vapor lamp with high pressure DRS 250-3 and DRS 500m serve for excitation of luminescence. The sample is placed into holder and illuminated by high-power monochromatic flux, yielded with the help of light filter (λ= 337.1 nm) from the spectrum of mercury-vapor lamp. Photoelectronic multiplier PEM-39A and PEM-62 served as an energy detector in the spectrometer. The curves of irradiation were recorded by electronic registering potentiometer KRP-4.

3. RESULTS
Study of photoelectric phenomena in monocrystals GaS1,2Sex: Er with different defects is of great interest from the aspect of other considerations too. That’s one of the main advantages of this semiconductor is that energy gap width, concentration and mobility of free charge carriers, energetic impurity level depth can be varied in very large range by change of composition.

In fig.1 spectrum dependencies of photoconductivity of the investigated samples before and after irradiation at T=300K were shown. Spectral region of monocrystals GaS1,2Sex: Er occupy wave-length zone 0.400 – 1.000mkm. There are two peaks λ = 0.540 mkm and λ = 0.800 mkm in the spectrum of photoconductivity of unirradiated samples.

Photoelectric current increases throughout the whole spectral region after irradiation by γ- quanta, at the maximum of intrinsic and impurity peaks shifts to shorter wave-lengths. Photosensitivity decreases by growth of irradiation dose (higher that Dγ> 100 krad). In fig.2 spectrum of photoluminescence of unalloyed monocrystals GaS1,2Sex before (curve.1) and after (curve.2) irradiation by γ-quanta at temperature 77K are given.
It seems from the figure that spectral region of irradiation of pure sample begins from 0.420 mkm and extends up to 0.620 mkm. Maximum of intensity band is λ = 0.541 mkm. Besides main emission band there is a band with maximum approximately 0.481 mkm too. After irradiation of (Dγ = 50krad) non-activated samples two wide bands with maximums (λ1 = 0.531 mkm and λ2 = 0.661 mkm) of irradiation occur.
In fig. 2b. and 2c. spectra of photoluminescent samples doped by erbium at 77K before and after irradiation are presented.

Intensity of luminescence of wide bands (λ = 0.541 mkm) decreases in monocrystals GaS_{1-x}Se_{x} activated by erbium and narrower lines (λ = 0.546; 0.549; 0.552; 0.557 mkm) referring to intracenter transition of ions Er^{3+} (fig. 2b) occur in the spectrum. After irradiation with dose 50 krad intensity of luminescent bands increases (fig. 2c.).

4. DISCUSSION OF EXPERIMENTAL RESULTS

It is known [2] that at doping monocrystals GaS_{1-x}Se_{x} Er enters into the lattice as an impurity, which involves gallium atoms in cationic sublattice of crystal, forming tiny donor centers. Apparently, impurity maximums of photoconductivity (λ = 0.800 mkm) are connected with these centers, which were observed at room temperature in monocrystals GaS_{1-x}Se_{x}:Er. Besides this, they are conditioned by photo-excitation of electrons with valence band to empty donor centers Er_{Ga} with consequent thermo-ionization to conductivity band at room temperature. Fast (s) and slow (r) centers play the main role in recombination processes in these crystals. Accordingly [3], the process of defect formation at irradiation may lead to stronger change of concentration of local levels as well as that of r-centers of photosensitivity.

It is difficult to determine the nature of new r centers according to the obtained experimental data and it can be supposed that these centers are responsible for complex of defects, the content of which also includes V_{Ga} and Er atom. Formation of such complexes at irradiation of GaS_{1-x}Se_{x}:Er is simulated by high Er atomic mobility and occurring at irradiation V_{Ga}. Occurrence of new r centers with concentration more that that of V_{Ga} before irradiation in the samples after irradiation leads to increase of photoconductivity and photoluminescence and decrease of dark conduction, [4] as these centers like other centers of slow recombination are acceptors.

Decrease of photosensitivity and intensity of all luminescent bands of the irradiated sample at higher doses (D_r > 100krad) of γ-quanta is evidently conditioned by several reasons. At γ- irradiation non-radiative “fast” centers of recombination are also displayed together with radiative centers, which redistribute a large amount of recombination flux of nonequilibrium carriers by accumulating. Besides, by increasing concentration of radiation defects screening action of some defects are increased by fields of other ones, which correspondingly leads to change in cross sections of carrier trapping by recombination centers and maybe increase of the role of non-radiative transitions, reducing quantum yield and photosensitivity of strongly irradiated samples [5].
5. CONCLUSION
Summarizing we can say that irradiation of monocrystals GaS$_{0.85}$Se$_{0.15}$:Er by $\gamma$-quanta leads to formation of tiny acceptor levels of attachment, compensating deep donors being sensed by $r$-centers of recombination which resulted in increase of photosensitivity and luminescence.

6. REFERENCES
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