LUMINESCENT PROPERTIES OF TRIPLE SEMICONDUCTORS UNDER THE ACTION OF X RAYS

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Abstract: this article focuses on the description of triple semiconductors of $A^{II}B_2^{III}C_4^{VI}$ type, especially $CdGa_2S_4$, and the researeh instalation over luminescent properties under the action of accelerated electrons and X-rays.

Key words: compounds, semiconductors, band, optoelectronics, cadmiitiogalat, catodluminescence, optoelectronics elements.

The triple semiconductors of $A^{II}B_2^{III}C_4^{VI}$ type possess extraordinary optic properties, having a large band of energy $(E_g \approx 3\ eV)$, a law sensibility for impurities and a highe stability for ionisation radiation. For practical aplication in optoelectronics an aspacialy interes reprezent the investigation of intesive luminescence, a high fotosensitivity in the visible and ultraviolet of the optic domain.

In the present worc there are presented the results of investigation of triple compound $A^{II}B_2^{III}C_4^{VI}$ iradiation spectra with high level of excitation. The luminescence excitation was realized by an flux of accelerated electrons and X- rays with the energy in the magnitude of $20 \div 50\ keV$.

If was investigated cadmiiteogalat $CdGa_2S_4$, from the family of $A^{II}B_2^{III}C_4^{VI}$. For this compound it is realised the advanced technologies for the grow , experimental control methods of compound and structure of crystal net. The cristals investigated in present paper were oltaired by mecans of transport chemical reactions.

Synthesis and growing of crystals were made in optic quartz cup of the length $150\ mm$ and at $20\ mm$ interior diameter. In the cup, previosly chemical processing were introduced the initial components (Cd, Ga, Zn, In, S) in correspond with the chemist formula and the transport medium – iodine of concentration about $4\,mg/cm^3$.

The chemical transport reaction occured at an temperature gradient at the $3{,}5\ K/mm$. Themost large and perfect monocristals of dimensions $10 \times 5 \times 3\ mm$ were obtained by means of many repeated transport processes.

In the present paper the catod luminescente excitation were realized by means of electron microscop ray of УЭМВ-100. The scheme of the electron gun used for experiment is illustrated in figure 1. The test were fix on a copper support cooled by means of liquid nitrogen and were introduced in working camera of microscope in which where keep an vacuum not more than 10^{-4} $mm\ Hg$.

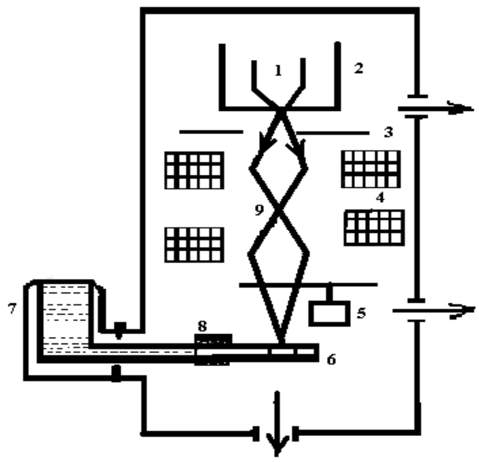

Fig.1. The electron gun and the system of electron beam.

1-Cathode, 2-focusing electrode, 3-anod, 4-condensers, 5-modulator, 6-investigated-test, 7-Diuar vessel, 8-heating element, 9-electronbeam.

The investigated tests are situated on a cooler of special construction.

Electron capture and registration of cathode luminescence radiation of the electron microscopy are represented in figure 2. It contains the optical part, which enable the possibility to accumulate optical radiation from crystal surface (test).

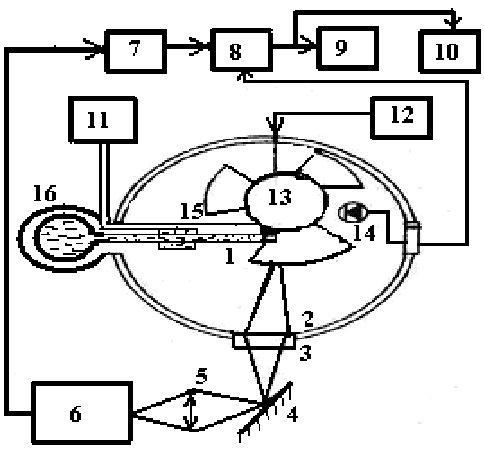

Fig.2. The system of capture and registration of luminescent radiation.

1-the test for investigation, 2,5-cuartz lenses, 4-mirror, 6-dispersion system situated on diffraction mirror, 7-amplifier, 8-sincrondetector, 9-registration potentiometer, 10-electronic voltmeter, 11-temperature stabilizer, 12-supply block of modulator, 13-electron modulator, 14-base source of voltage, 15-thermocouple, 16-Diuar vessel.

The light flux from the surface of the test by means of lenses and mirror were focused on the aperture of the device ИСП-51.As a photomultiplier was applied the device ФЭУ-18, and the other devices for registration the waves in the interval of $3800 \div 10000$ Å. The modulations of a given system enable to obtain flux pulse of a current of the duration of $100\,\mu s$. The modulator motor of a type ДИД-2 poses a stable rotational frequent cy and it is supply from an three- phase generator of the $360\,Hz$ frequency an the amplitude of $36V$.

For temperature stability in the interval of $80 \div 300\ K$ was used an electric storage space heater which were supply from a stabilizer included in the component of the microscopy. The temperature control was made by means of a thermocouple "copper-constantan".

The investigated tests previous were covered with a semitransparent metal layer (Al, In) through evaporation and respectively plating in the vacuum space. The metal layer eliminate the accumulation of electric charges on the surface of test and forbid creation of on electric field opposite that of accelerated one. This field would be lead to diminish of accelerated electrons energy; whir bombard the surface of mater and in this way would diminish cathode luminescence efficiency.

The real emission spectrum was calculated according formula $[1]$:

$$I_r(\lambda) = {I_f(\lambda)}\Big/{S(\lambda)} \qquad (1)$$

where $I_f(\lambda)$ is the value of fotoelectric signal recorder of fotomultiplicotor for the given wavelenqth, $S(\lambda)$ is the spectral sensibility of a aeviceth, experimental determined following the methods describen in $[1]$. The installation were certificated through the recording cathode luminescence spectrum of an test cadmium sulphide $(Cd\,S)$, the radiation spectrum of it were know $[2]$. The installation for the investigation of luminescence undoes X rays action is described in the paper $[3]$.

As a result of investigations according the cathodoluminescence and X-luminescence properties of $CdGa_2S_4$ it was established that the luminescence bands are situated in a large interval of energies: $1{,}5 \div 3{,}8\,eV$. The distribution of luminescence intensity in the spectrum is strongly influeneed of variation of external condition of excitations whir a due to variation of acceleration voltage of electrons and the surface density of a anodic current in the electronic gun, as well as the charge of a temperature . For the interpretation of the nature of luminescence bands in the spectral diapason $h\omega > 3{,}0\ eV$ were made the comparision with the experimental results obtained by other methods, for example, photoconductibility, electroabsrbtion in the impurities and others $[5{,}7]$. In this aspect the band of maximum $3{,}8\ eV$ may be explined by emission transitions of free electrons from conducting band into valence band, but maximum $3{,}19\ eV$ corresponds to transition for conducting band to acceptor level.

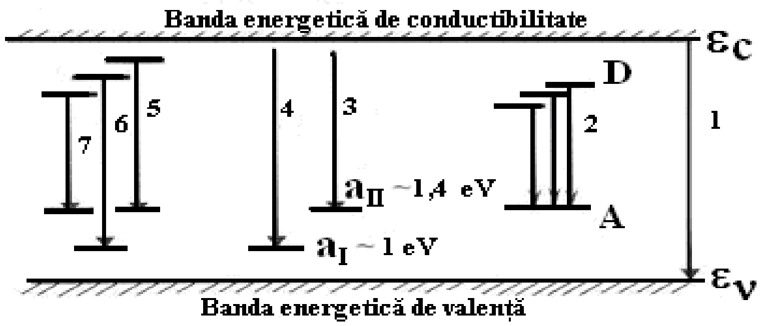

Fig.3. Model of energetic levels, type of transitions.

1-band-band, 2-donor-acceptor, 3-band-acceptor, 4-band-acceptor a_1, 5,6,7-transition from discret distribution of levels neor the conductibilityzone.

Acording to investigation results given before it is proposed the model of energetic levels from the intrinsec energy band and the emission transitions which explaned the luminescence bands of a cadmii tiogallat at the temperature of liguid nitrogen.

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