IMPROVEMENT OF CdZnTe RADIATION DETECTORS PARAMETERS BY LASER RADIATION

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Abstract

The effects of Nd:YAG laser radiation on the parameters of the CdZnTe radiation detector was studied. The enhancement of energy resolution, especially at low energies, and electrical resistivity of the CdZnTe detector takes place after irradiation by the laser. This effect is explained by Thermogradient effect.

Keywords: *CdTe, CdZnTe, x-ray, γ- ray, laser.*

The semiconductor CdTe and CdZnTe single crystals are very promising materials for room temperature X- and γ- ray imaging and spectroscopic applications due to the large bad gap, high stopping power, high μτ product [1]. The use of CdZnTe material as radiation detectors, electro-optical modulators, laser windows and substrates for epitaxial growth of HgCdTe is still limited by some important problems such as the presence of Te inclusions, Cd vacancies, crystal twins, grain boundaries, dislocations and other defects [2]. The thermal annealing in furnace is used to improve the crystal quality [3]. The possibility to improve crystal quality by CO_2 laser irradiation has shown (LR), but this method leads to the damage of the crystal surface during laser processing [4, 5]. We have showed a possibility to improve electrical properties and parameters of CdZnTe radiation detectors using weakly absorbed Nd:YAG laser radiation.

Single crystals of $Cd_{1-x}Zn_xTe$ with x=0.1 grown by High-Pressure Vertical Zone Melting method characterized by high concentration of non-controllable impurities and Te inclusion were used in our experiments. Nd:YAG laser with the following parameters: wavelength $\lambda = 1.064$ μm, pulse duration $\tau = 15.0$ ns, power P = 1.0 MW was used. Irradiation of the crystals with intensity I=5.0 MW/cm^2 and maximum number of the laser pulses 3.6×10^4 was carried out. To characterize the change of CdZnTe crystal lattice quality after irradiation by laser, Fourier Transform Infrared Spectroscopy (FTIR) was used. Experiments were carried out at room temperature, atmospheric pressure and humidity 60%. Transmission spectra of non irradiated and irradiated samples by the laser radiation are shown in figure 1. The slope of transmission spectra is decreased after irradiation of CdZnTe samples by the laser. The same samples current voltage (I-V) characteristic measurements where performed. I-V characteristic measurements showed that sample resistivity is rising after irradiation with

3.6×10^4 laser pulses by 45%, as shown in figure 2. After reaching specific number of pulses, saturation effect can be observed. It means that no more changes of CdZnTe sample resistivity were observed.

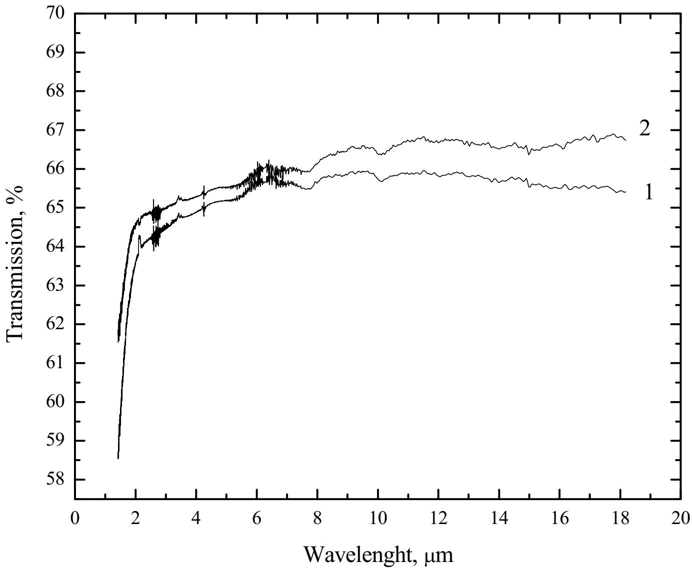

Fig.1. Transmission spectra of CdZnTe samples before (curve 1) and after irradiation (curve 2 -with pulse number 3.6×10^4 pulses) by the Nd:YAG laser.

Increase of CdZnTe samples resistivity is explained by presence gradient of temperature in the crystal [6]. Gradient of temperature arises in volume of crystal due to strong absorption of the LR by Te inclusions. As a result small inclusions and interstitial impurities drift to the maximum of temperature, towards the biggest Te and In inclusions, and precipitate [7]. To characterize sample as radiation detector γ-ray spectroscopy measurements was used.

It was observed that after irradiation of CdZnTe samples by the laser leakage current reduces by 45% and samples act as a better radiation detector due to improved energy spectral resolution, especially at low radiation quantum energies.

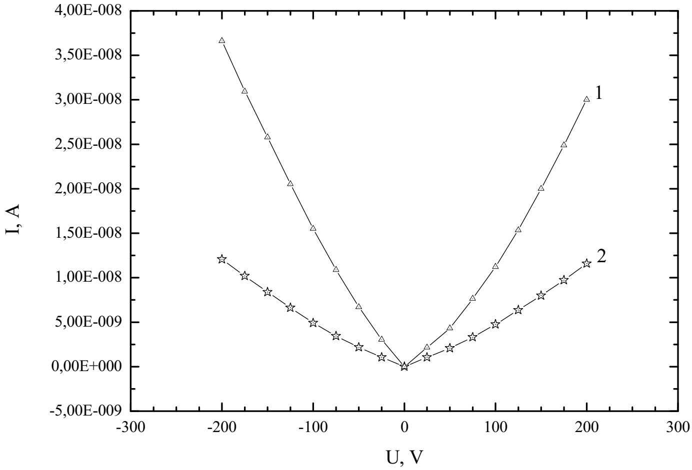

Fig.2.The I-V characteristics of CdZnTe crystal before (curve 1) and after irradiation (curve 2) by the laser at intensity I = 5.0 MW/cm^2 and pulses number 3.6×10^4.

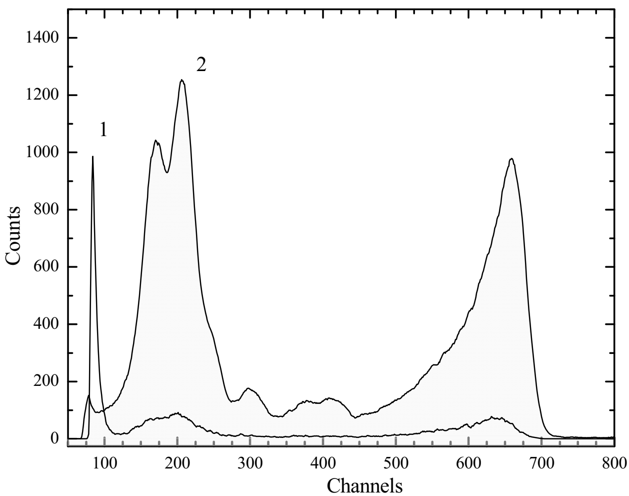

Fig.3. ^{241}Am gamma-ray spectrum obtained with CdZnTe detector before (curve 1) and after irradiation (curve 2) by Nd:YAG laser at intensity I = 5.0 MW/cm^2.

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