Tarpsluoksninių įtempimų modifikavimas $TlInS_2$ kristaluose *Erbio* legiravimu

Modification of interlayer stresses in $TlInS_2$ crystals by *Erbium* doping

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Thallium based dichalcogenides possess a number of unique optical, photoelectrical and ferroelectric properties due to specificity in their layered structure contrary to the bulk 3D semiconductors. Among the other dichalcogenide compounds $TlInS_2$ attracted strong attention for promising potential applications [1]. Significant difference of physical parameters measured along the layer planes and normal to them is observed. Interaction between the layers and anisotropy of the crystals is very sensitive to the dislocations and/or planar stacking fault (PSF) defects and impurities accumulated in the region between layers. It has been proposed that in the similar layered crystal $TlGaSe_2$ a stacking fault occurs about once every four planes on average [2].

This study is an attempt to investigate the changes of the interlayer stresses by doped the $TlInS_2$ crystal with certain elements. The photoluminescence (PL) reflects peculiarities of electronic collective excitations in semiconductors. In spite of a great body of information about $TlInS_2$ there is a lack of works devoted to the PL study of such crystals and available data is contradictory. By means of the confocal microscopy which allows measurements on selected position of the layer plane as well as the lateral surface of the sample with changing excitation light polarization in respect to crystallographic axis the measures were carried out in a wide range of temperatures and energies of excitation. Three different experimental geometries were used for PL measurement. The wave-vector of the exciting radiation, **k**, was either parallel (**k**||**c**) or normal (**k**⊥**c**) to the **c**-axis. In the case of **k**⊥**c**, the excitation light polarization could be set to be either parallel (**E**||**c**) or normal (**E**⊥**c**) in respect to the **c**-axis while in the **k**||**c** case the polarization is always normal to the **c**-axis (**E**⊥**c**). In this case, a configuration of exciting light incidence and polarization were obtained by rotating the sample.

Table 1. Position of PL peaks (in eV) in $TlInS_2$ single crystals for different configurations at 295K

Dopant	***k*||*c***	***k*⊥*c*, *E*⊥*c***	***k*⊥*c*, *E*||*c***
Undoped	2.403	2.359	2.397
Er-doped	2.395	2.348	2.384

The extracted energies of Gaussian PL peaks at RT are outlined in the Table 1. In contrast to the PL of $TlInS_2$ doped by *Ag* and *B* [3] the strong enhancement due to the *Er* incorporation is clearly detected at all excitation configurations. The PL in *Er* containing sample is typically stronger by a factor of 3–10 at RT while it increases in 10–60 times at low temperatures.

The PL spectra of undoped and *Er*-doped $TlInS_2$ measured at low temperature are presented in Fig. 1. They demonstrate a complex structure containing sharp high-energy components. Either of the two spectra was fitting by a set of Gaussian curves each of them suggests its own mechanism of photon emission. As one can see the incorporation of *Er* into $TlInS_2$ significantly changes the PL spectrum. Furthermore, the *Er* doping of the sample enhances the emission intensity in the intrinsic PL band. It can be assumed that *Er* atoms reduced interlayer stress caused by PSF defects in layered structure.

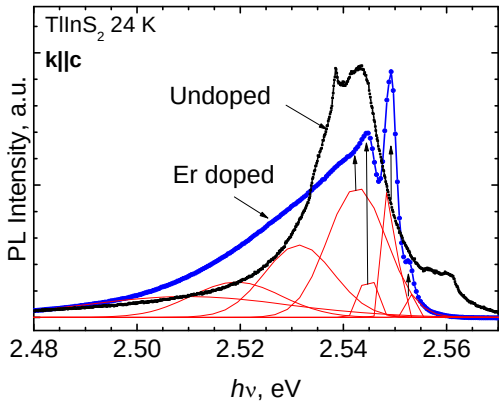

Fig. 1. PL spectra of undoped and *Er*-doped $TlInS_2$ crystal measured at 24 K in the excitation direction **k**||**c**. Fitting by a set of Gausslines is given for the *Er*-doped sample

Keywords: $TlInS_2$, layered semiconductor crystals, photoluminescence, Erbium doping.

Reference

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