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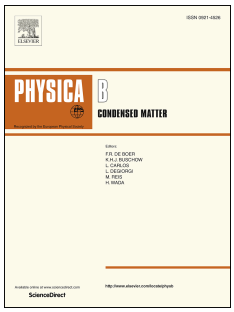

Effect of Dy-doping on photoluminescence properties of CdTe crystals and their defect structure

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Effect of Dy-doping on photoluminescence properties of CdTe crystals and their defect structure

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Highlights

- The structure of the photoluminescence (PL) and exciton reflection spectra was studied.
- Free and acceptor (donor)-bound excitons as well as polaritons were observed.
- It was revealed that the broad PL bands are caused by DAPs emission and (e-A) transitions.
- The photoionization energy of Na(Li) residual impurities and other defects was found.
- Doping of CdTe crystals with Dy considerably improved their optical quality.

Abstract

The gettering effect by rare earths (RE) in semiconductor CdTe crystals was studied using the photoluminescence (PL) measurements. It was shown that the low-temperature PL spectra of Dy-doped CdTe crystals exhibit two acceptor-bound exciton lines, namely, the most intense sharp A_1^oX-line and a low-intensity A_2^oX-line associated with the residual Na(Li) impurity atoms and the cadmium vacancies, respectively. In addition, the donor-bound exciton lines are also observed. It was shown that these lines are caused by the presence of the Cl residual impurity atoms, interstitial Cd_i or $Na_i(Li_i)$ atoms. The PL of donor-acceptor pairs and the emission caused by optical transitions of (e-A) type were revealed. The nature and photoionization energy of different donor and acceptor centers were determined. It was found that the emission associated with the presence of complex acceptor centers is absent in PL spectra. This indicates that the concentration of dislocations is very small for the investigated crystals. The presence of bound and free excitons in the PL spectra as well as free excitons in the reflection spectrum shows high crystalline and optical quality of CdTe:Dy crystals that is due to so-called “cleaning” process of the semiconductor materials by their doping with RE elements.

Keywords : II-VI semiconductors; optical properties; exciton; defects; rare earth elements.

1. Introduction

CdTe crystals are very attractive semiconductor materials, as they have wide applications in the development of various devices of modern optoelectronics, in particular, solar cells, photodetectors, X- and gamma-detectors, etc [1-6]. The efficiency of the application of these crystals, as well as of any semiconductor materials, is largely determined by their electronic