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Laser spectroscopy of optoelectronic phenomena in $ZnSiP_2$ crystals

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Study results have been presented on the extrinsic and band states of carriers in $ZnSiP_2$ crystals made by solution-melt crystallization. Using the laser modulation spectroscopy, doped centers have been found having a very large hole capture cross-section from the valence band. Their effect on quantum transition features in $ZnSiP_2$ has been demonstrated.

Приведены результаты исследований примесных и зонных состояний носителей в кристаллах $ZnSiP_2$, полученных методом кристаллизации из раствора в расплаве. Методами лазерно-модуляционной спектроскопии обнаружены примесные центры с очень большим сечением захвата дырок из валентной зоны и показано их влияние на особенности квантовых переходов в $ZnSiP_2$.

The tetragonal modification of $ZnSiP_2$ semiconductor [1, 2], although still scarcely studied today, is believed to be among materials of promise for optoelectronics and quantum electronics. This material, as well as $ZnGeP_2$, exhibits a record high nonlinear susceptibility. The optical properties of $ZnSiP_2$ are known to be very sensitive to the growth conditions [3]. Therefore, it is of interest and importance to study in detail the impurity and band states of the carriers in of $ZnSiP_2$ crystals grown by different techniques.

Theoretical calculations allow to obtain only a qualitative picture of the of $ZnSiP_2$ band structure [4, 5] while experimental studies are necessary to determine quantitatively the doped and band structure parameters. The modulated laser spectroscopic study of crystals grown by gas phase synthesis from the previously synthesized compound using of $ZnCl_2$ as the transporting agent have been made in [6]. In this work, the study results are presented for $ZnSiP_2$ samples obtained by crystallization from the solution in Sn melt [7]. The experimental setup has been described in [8].

All the samples had the hole conductivity and the energy gap width 2.10 eV at 295 K. The experiments were made at room temperature. The change of the probing wave (frequency ω_2) absorption coefficient in the crystal due to the medium excitation with the pumping wave (frequency ω_1) was determined [6]:

$$\Delta K(\omega_2,t) = \frac{1}{z}\ln\frac{1}{1 + \Delta h(\omega_2,t)/h_0(\omega_2)}, \quad (1)$$

where $h_0(\omega_2)$ is the electron beam deviation on the oscillograph screen from the zero level position due to the probing light ω_2 at $t_0 = 0$; $\Delta h(\omega_2,t)$, the electron beam deviation from the $h_0(\omega_2)$ level due to the laser pulse action; z, the sample thickness (0.627 mm). A modulated-quality neodymium laser ($\hbar\omega_1$ = 1.17 eV) with the pulse duration τ_1 = 31 ns was used as the pumping wave source while probing radiation and illumination were provided by xenon pulse lamps