OPTICAL CHARACTERIZATIONS OF THE GAAS QUASI-DELTA-DOPED SUPERLATTICES

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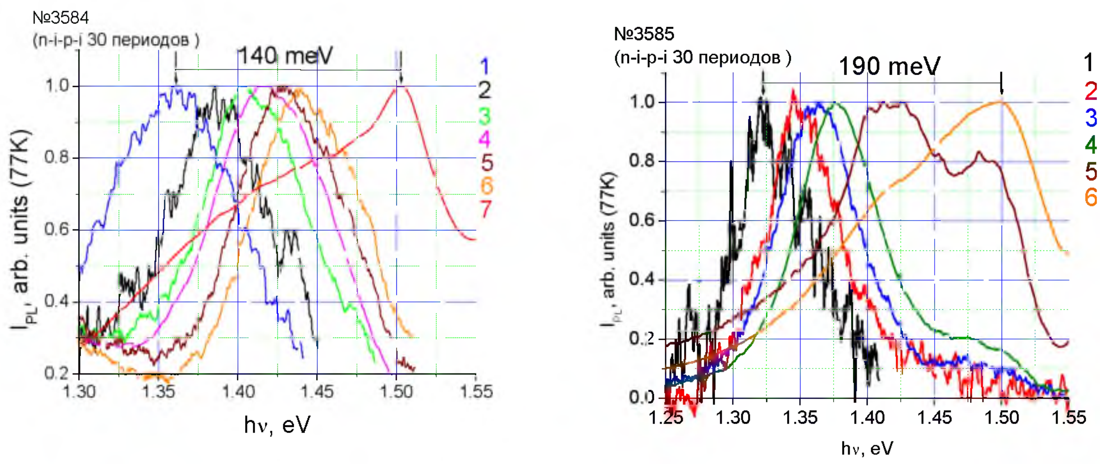
Doping superlattices have advanced properties for the development of novel optoelectronic devices. Using the delta-doping techniques extends possibilities of the superlattice design and allows improving the characteristics in comparison with homogeneously doped *n-i-p-i* structures. For the δ-doping, molecular beam epitaxy is most widely applied [1]. The GaAs δ-doped superlattices were also grown by metal-organic vapor-phase epitaxy [2, 3]. For *n*- and *p*-type δ-doping, Si and C were used and tunable low-temperature photoluminescence (PL) was demonstrated.

In this work, the GaAs short-period superlattices have been grown for the first time by the metal-organic hydride epitaxy method using Se and C for quasi δ-doping. Earlier, such a method was applied for making the photosensitive heterostructures with the GaInAs quantum-well spacer [4].

Parameters of the formed GaAs δ-doped superlattices corresponded to photonic crystals. Structure No. 3584 has a 30-period superlattice with the period of 19 nm and 7 nm thick *i*-layers. The thickness was 0.8 μm, including a 0.2 μm buffer layer and a 0.1 μm top layer. The sheet concentration of donors Se is 1.5×10^{13} cm^{-2} and of acceptors C is 1.6×10^{13} cm^{-2}. Structure No. 3585 has similar design with the period of 29 nm and 11 nm thick *i*-layers. The structure thickness was 1.2 μm.

The luminescence characteristics of the grown δ-doped superlattices were measured at CW excitation by the 488 nm radiation of an Ar^+-ion laser. At the structure temperature $T = 77$ K in the spectral region near 1.4 eV, the tunable PL in dependence on the power excitation is observed (Fig. 1). The PL spectrum for structure No. 3585 is shifted to the long-wavelength region and its tuning bandwidth is larger as compared structure No. 3584. Since the thickness of the *i*-layers in structure No. 3585 is approximately in one and a half times more than in structure No. 3584, the superlattice effective energy band gap must be smaller for the first one and it exhibits a greater tunability under optical excitation. In addition, it provides a narrower linewidth of the PL spectrum.



(a) (b)

Fig. 1. PL spectra of structures (a) No. 3584 and (b) No. 3585 in dependence on the power excitation *P* (curves 1-7) at *T* = 77 K. Spectra 1 correspond to *P* = 10 mW, spectra (a) 7 and (b) 6 are observed at *P* = 1kW

Low-temperature PL measurements (*T* = 4.2 K) show that in the spectral region of 1 eV an intensive broad luminescence band exists. At the long-wavelength edge (0.9 eV) of this PL band a weak line displays. The same shifted PL emission is observed at *T* = 77 K in the regions of 0.95 and 0.83 eV respectively. Such PL lines can be associated with deep levels of residual impurities or related complexes. To determine nature of the observed PL bands, more detail investigations are required.

In addition, optical characterization of the structures was carried out using transmission and Raman spectroscopy techniques. Under excitation by laser radiation at room temperature both superlattice structures exhibit a noticeable increase of the transmission in the spectral interval 1.2 to 1.4 eV. Energies of LO and TO phonons are closed to the values for bulk crystals.

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