Pulsed Electron Beam Pumped Laser Based on ZnCdSe MQW Structure With High Threshold of Catastrophic Degradation

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Abstract—The parameters of electron beam pumped RT lasers based on ZnSe-containing MQW structures were studied. Maximum value of output pulse power as high as 82 W per laser facet has been demonstrated. Both the high value of \( P_{\text{max}} \) and the threshold of catastrophic degradation in comparison with the earlier results could be explained by the relatively low level of defect density (~10^4 cm^-2) in the laser structure.

Keywords—electron beam pumped lasers, MQW-structures, superlattice waveguide

Pulse electron beam pumped (EBP) semiconductor lasers are prospective for using in optical location, navigation and communication systems etc. It has been demonstrated that employing ZnSe-based QW structures grown by molecular beam epitaxy (MBE) as active elements of EBP lasers allowed the reduction of electron pumping energy \( U_e \) to the values less than 4 keV \((T = 300 \, \text{K})\) [1]. However, the maximum values of output pulse power \( (34 \, \text{W} \text{ for single laser and above 600 W for laser array at } U_e = 27 \, \text{keV}) \) of these lasers are restricted by the catastrophic degradation of the active element [2].

This paper presents the characteristics of room temperature EBP green laser with an extended waveguide and low density of structural defects. The ZnMgSSe/ZnCdSe laser structure has been grown by MBE on GaAs (001) substrates using SemiTEq (Russia) MBE setup. The structure consisted of a lower and upper Zn_{0.9}Mg_{0.1}S_{0.15}Se_{0.85} cladding layers, alternately-strained short-period \( \text{ZnS}_{0.14}\text{Se}_{0.86}/\text{ZnSe} \) superlattice waveguide, and an active region based on six 5-nm-thick ZnCdSe QWs equally spaced in 2.13-\mu m-wide waveguide. The structure design has been elaborated using strain compensation concept [3]. Electron beam with the pulse duration time of ~0.3 microseconds and energy up to 30 keV was used for the pumping.

The laser wavelength near the threshold is of 537 nm. Maximum output pulse power \( (P_{\text{max}}) \) as high as 82 W per facet (at the efficiency of ~2.5%) has been demonstrated. The upper \( P_{\text{max}} \) value was limited by the catastrophic degradation of active element. The laser parameters were the following: cavity length \( L = 1.1 \, \text{mm} \), transverse size of the pumped region \( h = 0.65 \, \text{mm} \), \( U_e = 27 \, \text{keV} \). The reducing of the cavity length \( L_{\text{cav}} \) was followed by the increase of the efficiency, the maximum value of 8.6% was measured at \( P = 30 \, \text{W}, L = 0.4 \, \text{mm}, h = 0.24 \, \text{mm}, U = 21.4 \, \text{keV}, j = 18 \, \text{A/cm}^2 \). Both the high value of \( P_{\text{max}} \) and the threshold of catastrophic degradation (in comparison with the earlier results [2]) could be explained by the relatively low level of defect density (~10^4 cm^-2) in the laser structure.

References

